JULY 1948

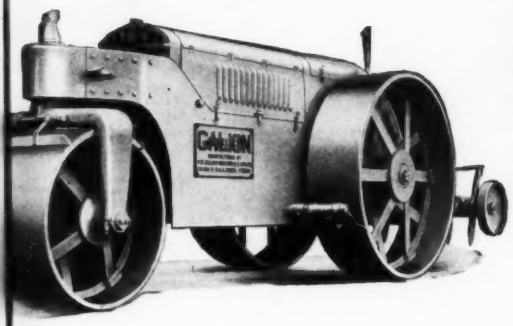
Public Works Magazine

IN THIS ISSUE:

How to Build Low Cost Roads

Twin Waste and Industrial Sewers

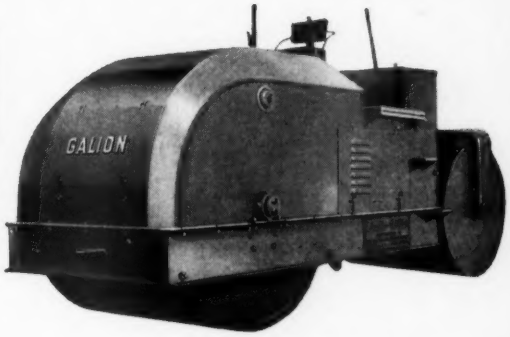
Amarillo's Water Works



BETTER ROADS FOR A BETTER WORLD

45th Annual Convention and Road Show
SOLDIER FIELD
CHICAGO
JULY 16-24, 1948

Spaces 2206, 2405, 2408 and 2607
North Concourse

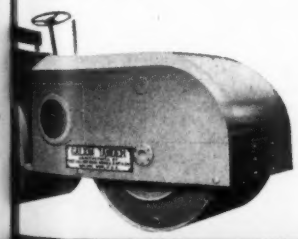


7, 8, 10, and 12 Ton
THREE-WHEEL

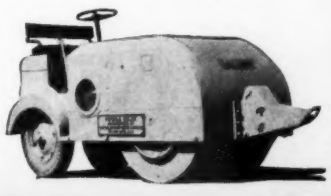
8, 12, and 14 Ton
TANDEM

OHIO STATE UNIVERSITY
JUL 16 1948
LIBRARY

3-5 Ton
TANDEM



PORTABLE
ROLLER



THE
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IRON WORKS & MFG. COMPANY
General and Export Offices
Galion, Ohio, U. S. A.

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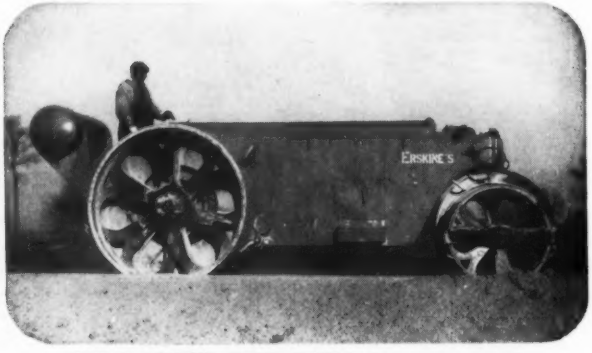
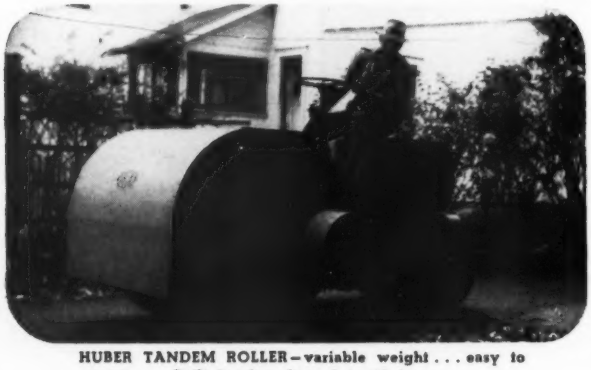
CONTROL COSTS

HUBER MAINTAINER for road maintenance work can't be beat. It requires only one man to operate. Blade and tools hydraulically operated.

THE HUBER WAY



HUBER 3-WHEEL ROAD ROLLER—fast . . . economical . . . dependable. Built in sizes from 5 to 12 tons.



HUBER TANDEM ROLLER—variable weight . . . easy to operate . . . Built in sizes from 3 to 12 tons.

High labor and material costs, plus shortages in both, make it imperative that road men employ the most efficient time and cost saving machinery today. To control costs the Huber way is to switch to modern, speedy, and economical Huber Road Machinery in recognition of its far-flung reputation for cutting costs to the bone.

Whether you use a Huber 3-wheel Automotive Type Road Roller with its ready adaptability to every rolling operation—a Huber light weight, versatile Maintainer that serves as a bulldozer, broom, snow-plow, patch roller or lift-loader with one operation—a Huber streamlined variable weight Tandem Roller of unusual maneuverability—they just cannot be surpassed when it comes to saving time and money. Any Huber Road Machinery user will tell you this.

Ask your local Huber distributor to give you all the facts about Huber Road Machinery. He would like to work with you.

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HUBER

3 Wheel • Tandem

ROAD ROLLERS *and* MAINTAINERS

Precision Engineered for Long, Hard Service

15 Years of Service . . . Over 1700 Installations

THE COMMINUTOR

Is Specifically Designed to Screen and Cut Sewage Solids Under Water

From the Mediterranean to the Philippines; from the Arctic Circle to Australia, wherever there is modern sewage treatment, you will find Comminutors. Such world-wide acceptance is based on a machine that efficiently and effectively performs a service unmatched by any other type of equipment.

The Comminutor, compact, economical, silent, does away with the need for screens, rakes, grinders, burial pits and incinerators or other means of destroying the filth that is obtained by the old methods. With no screenings to stand in the open, there is no odor, no additional labor, and none of the unsightliness usually connected with screenings and their disposal.

The sturdy construction of the Comminutor is the result of long experience. The drum is a single casting, precision machined to close tolerances. Cutting bars, combs and teeth are firmly seated, yet easily removable for sharpening or replacement. They are staggered and distributed to effect multiple small shearing actions. This, plus inertia of the drum in motion, and gearing, allows use of small motors with consequent power economy. No housing is required for the Comminutor.

The Chicago Pump Company Comminutor is the result of many years of research and trial. "Bugs" in early models have long been eliminated so that the machines in use for many years have established an incomparable record of successful performance in the field.

If you have work in the sewage treatment field, write today for the Comminutor Bulletin which gives complete engineering data.

CHICAGO PUMP COMPANY

SEWAGE EQUIPMENT DIVISION

COMMINUTORS • SWING DIFFUSERS •
FLUSH-KLEENS • 'PAKAGE' PLANTS •
CRU-PELLERS • SAMPLERS • NON-CLOG PUMPS

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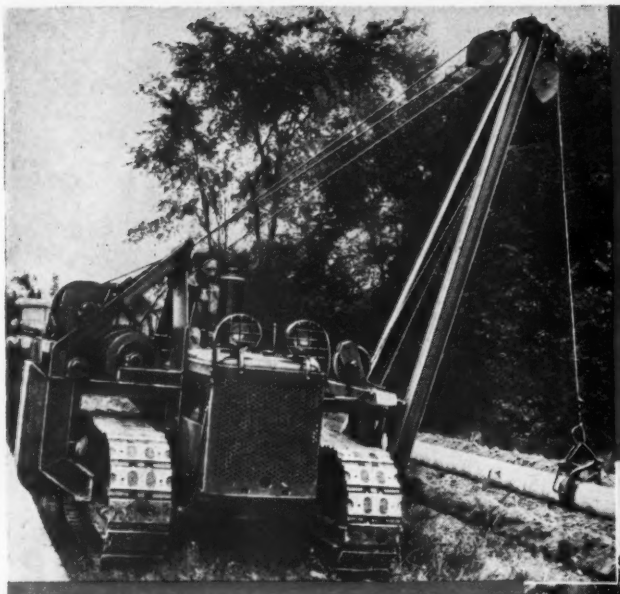
Vol. 79 PUBLIC WORKS No. 7

Published monthly by PUBLIC WORKS JOURNAL CORPORATION, 310 East 45th St., New York 17, N. Y. Subscription Rates: U. S. A. and Possessions, $3.00. All other countries, $4.00.

JULY, 1948



From WATER MAINS to WASTE DISPOSAL

INTERNATIONAL POWER Does the Job

From laying water mains in Grand Rapids to disposing of waste in Dade County, Florida, International Diesel Crawlers handle jobs with speed — at low cost.

Above, left, you see an International TD-9, equipped with a pipe boom, holding an 8-inch water main for welding. Twenty miles of this pipe were laid around the west side of Grand Rapids to prepare for industrial expansion.

At the right is an International TD-14 leveling waste from Miami suburbs in Dade County. The tractor spreads 16 to 24 inches of dirt over the filled-in area which will eventually become a park.

These are but two of the hundreds of jobs which International Power is doing for municipalities all over the country.

Check your power requirements with your International Industrial Power Distributor. He can show you how International Power becomes a versatile municipal asset in your community.

Industrial Power Division

INTERNATIONAL HARVESTER COMPANY

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Tune in James Melton on "Harvest of Stars" CBS Wednesday Evenings

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CRAWLER TRACTORS • WHEEL TRACTORS DIESEL ENGINES • POWER UNITS

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PUBLIC WORKS Magazine

Edited by
W. A. HARDENBERGH and A. PRESCOTT FOLWELL

JULY, 1948

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Published monthly by PUBLIC WORKS JOURNAL CORPORATION

Editorial and advertising offices: 310 East 45th St., New York 17, N. Y.

W. A. HARDENBERGH, *President;* CROXTON MORRIS, *Vice President and Treasurer;* A. PRESCOTT FOLWELL, *Secretary. Advertising representatives:* New York: ARTHUR K. AKERS, *Advertising Manager;* Chicago 11: LEWIS C. MORRIS, *Western Manager,* 612 N. Michigan Ave.; Cleveland 10: ROBERT J. SHEA, 2 Villa Beach, 15445 Lake Shore Blvd.; Los Angeles: SIMPSON-REILLY, LTD., Garfield Bldg.; San Francisco: SIMPSON-REILLY, LTD., Russ Bldg.; Seattle 4: SIMPSON-REILLY, LTD., New World Life Bldg.; Texas: FRANCIS BURT, 5341 Bonita Ave., Dallas 6. SUBSCRIPTION RATES: U.S.A. and Possessions, $3. All other countries, $4. Single copies, 35¢ each.

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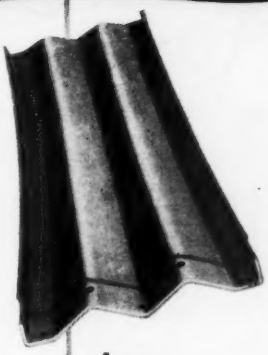
This tunnel liner



has championship form

Take a good look at the corrugated shape of ARMCO Liner Plate. It's the design that gives you safe strength without excessive weight. On a pound for pound basis these plates are in a class by themselves. They save you money and speed the job on sloped or vertical shafts.

Less bulk means that one unskilled workman can carry, hold, and bolt into place an ARMCO Liner Section. Only a structural wrench is needed. Labor costs are low and the job goes fast. Less excavation is needed and storage requirements are smaller. With ARMCO Plates you buy no excess metal and this keeps job costs down.

You'll find ARMCO Liner Plates the simplest, most inexpensive way you ever saw to install conduits, sewers and similar structures. The hazards and inconvenience of open trenching are avoided and business above ground goes on as usual. Write for prices and complete information. Armco Drainage & Metal Products, Inc., 3985 Curtis Street, Middletown, Ohio.

ARMCO LINER PLATES

TRAFFIC CONTROLS

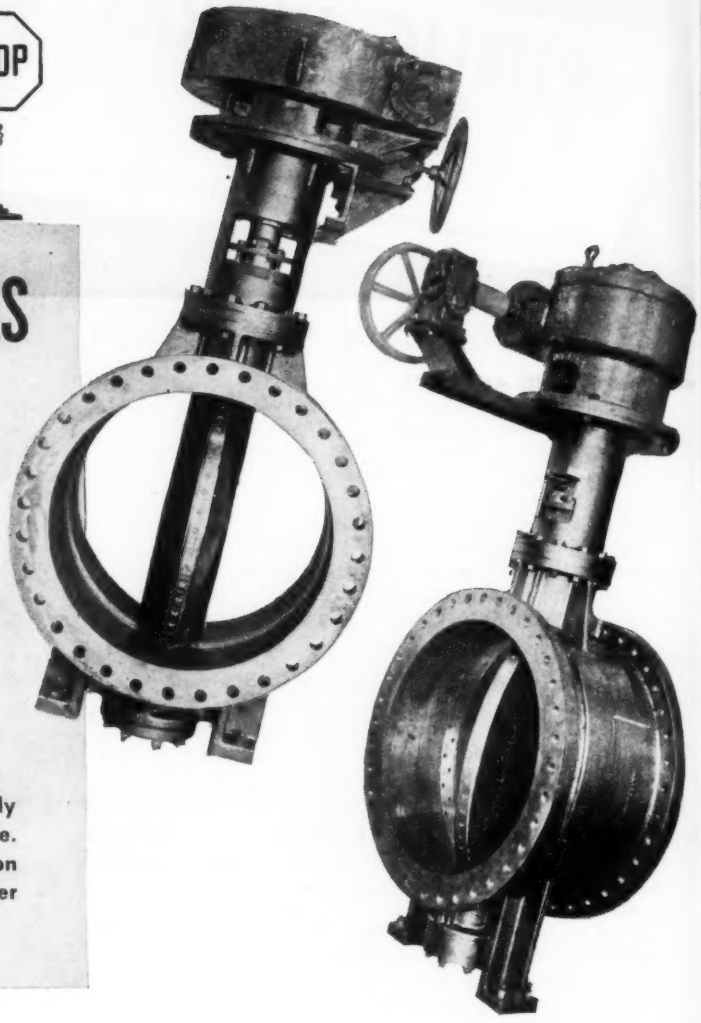
for San Diego water supply

fitted with

Everdur

AND BRONZE

Key parts of these 36" and 42" butterfly valves are made of Everdur and Bronze. Valves made by Coldwell-Wilcox Division of Krajewski-Pesant. Hydraulic Engineer for the city of San Diego: Fred D. Pyle.



DOWN from the Alvarado Regulating Reservoir rushes the water supply for San Diego, California, under 100 lb. pressure. Among the controls for this man-made underground river are these two butterfly valves, 36" and 42" I.D., which together weigh 16,000 lbs.

Many vital parts of these valves are made of Everdur* Copper-Silicon Alloys to insure long, dependable service. The shafts (respectively 5" and 5½" diam.) and seating rings in the body and in the disc are of Everdur. The ⅜" seating rings are fastened with Everdur screws. The stuffing box followers are of bronze with Everdur bolts throughout.

Why was Everdur chosen for this critical service? Because these famous alloys have proved thoroughly reliable in hundreds of water and sewage works applications. As a group, Everdur Alloys combine excellent corrosion resistance with high tensile strength, high fatigue limit, and good workability by all methods, including welding.

It pays to be familiar with the many ways in which you can take advantage of Everdur Alloys. For detailed information, write for Publications E-11 and E-5. 48194

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The Editor's Page

Fingernail Biting Won't Get Very Far

As John Ruskin has said: "There is hardly anything in the world that some man cannot make a little worse and sell a little cheaper, and the people who consider price only are this man's . . . prey." This statement applies with particular force to public works construction, where the intent should be to provide the public with structures capable of long-time service and trouble-free operation. There should be no cutting of corners, but neither should there be undue wastefulness. We believe that the great bulk of city, county and state engineers think as we do and practice this policy to the best of their knowledge and ability.

This editor's opinion on the subject being tolerably well known, and he also being a fairly good listener, his shoulder is kept quite moist by a few manufacturers who constantly moan that they cannot possibly sell their excellent products in competition because engineers always buy on price. This is bosh, buncombe, or what have you; and a reflection on the honesty, ability and knowledge of our engineers. What these moans really indicate is the failure on the part of these manufacturers to provide sound technical information on their newer and better processes, equipment and methods. The columns of this and other technical magazines are always open for the publication of reliable and helpful technical data, and constantly invite such contributions.

As we have said many times, only the best of materials should go into structures designed for our public services. The engineers who design these structures and specify the materials and equipment that go into them are capable and conscientious. But they cannot and will not seek out the manufacturer, even of a good product, who takes a defeatist attitude and regards them with unjustified suspicion. They need to be told what a product will do and why it is good, or better, or the very best in its line. And that is a job that the manufacturer must do for himself; no one is going to do it for him.

30% of 30% Isn't Enough

Speaking before the Illinois Society of Professional Engineers, Clarence W. Klassen reported on a survey of engineers covering several states. This survey is a part of the program being carried on by the National Society of Professional Engineers and the American Society of Civil Engineers to insure better utilization of engineers in the military services. Based on this survey, Mr. Klassen estimates that about 30% of all engineers can meet physical requirements for military service. This is arrived at by separating engineers into age groups and applying to each age group the rejection factor determined as a result of World War II experience.

Another recent survey, made jointly by the engineering societies and an agency of the army, indicated that only a little more than 30% of the engineers who were in military service reported that they had been used to the full extent of their abilities and in their major specialty.

If these figures are correct, and there is no reason to doubt them, they mean that the military services, under present conditions, will be able to utilize less than 10% of the engineering skills of the nation. This isn't enough; and that fact points the way very clearly to the need for overhauling our present outmoded and inefficient methods governing the military use of engineers.

Fortunately, there are those in the military services who realize the need for improvement; and there are committees representing the major engineering societies now at work on this problem. This may not be enough. There must be help and support from those engineers who will be most vitally affected in another emergency, as well as by those engineers who have the obligation of leadership for the younger men.

Let's Try to Prevent Construction Accidents

This is the construction season, and lots of people get hurt on construction jobs. In many parts of the country spring has been late in coming, and much rain has put many jobs behind schedule. That means work will be pushed; and that, in turn, means more accidents unless steps are taken to prevent them.

It costs money to prevent accidents, but less than to have them. Now is the time to review the job you have under way, whether it is a bridge, a building, a road or a sewer. Walk over and look over it and try to figure out where accidents are most liable to happen. Then figure out what simple steps are possible that will reduce the liability of accidents. No one not on the job can help you very much; it's your own responsibility, and common sense will go a long way in solving the problem. Take the time to look over your job, and save money and explanations by preventing accidents.

The Medical Department Changes Its Mind

Late in May the Medical Department of the Army called a conference of leaders in the non-medical scientific field, primarily to determine the ailments afflicting the Medical Allied Science Section of the Medical Service Corps. Well, they found out; and how! The professional non-medical men had a sort of a field day; and it is pleasant to note that the doctors took their medicine and asked for more. The result will probably be the introduction of remedial legislation at the next session of Congress which will (a) create a separate technical or scientific corps with adequate experience and educational requirements; and (b) will eliminate the present discrimination in promotion. These are two matters for which we have fought since before leaving Washington. The Medical Department is to be congratulated in acquiring that new look and newer viewpoint as younger highly capable men come to the fore.

BOWSER *diatomite filtration*

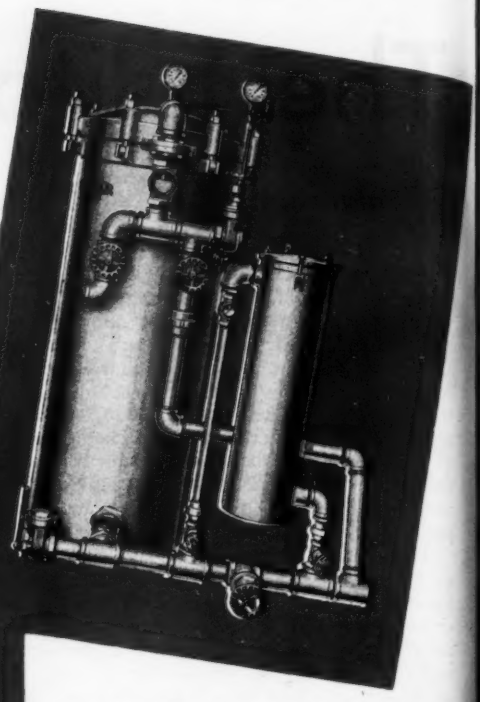
ESTABLISHED 1885

CUTS POOL OPERATING COSTS

Many installations prove conclusively that Bowser Diatomite Filtration yields clearer water at lowest filtering cost. Engineers and pool operators agree that the Bowser method far exceeds conventional filter performance.

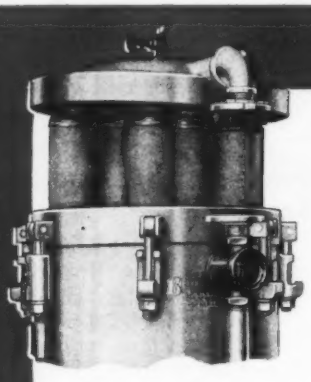
Long filter cycles, less backwash water, lower bacteria count, zero turbidity, no coagulants, 1/10 the floor space, no dismantling of equipment . . . all these are obtained when Bowser Filters are installed.

Bowser Filters do not require skilled operators. Valve control accomplishes backwashing, draining and diatomaceous earth precoating. No high capacity backwash pumps are needed.

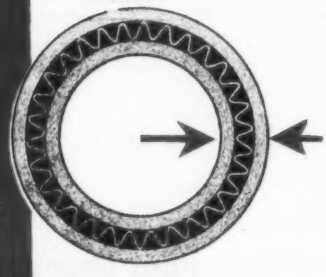


The above illustration shows the Bowser Fig. 610-200 Diatomite Filter with Precoat Pot. All piping, valves, flow sights, unions and flanges are supplied as standard equipment with all sizes to provide easy, convenient installation. Bowser Filters are Bowser-built and thoroughly dependable.

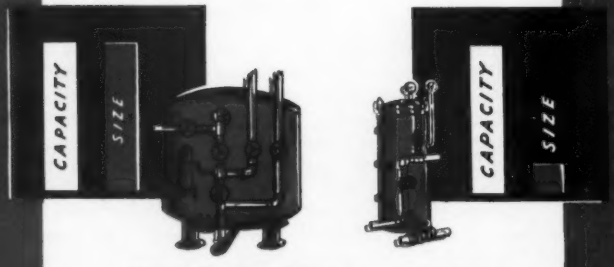
Bowser Filters may be installed indoors or outdoors where freezing conditions are not encountered during operation. Available in several sizes, they may be installed in tandem for very large requirements.



Complete accessibility is an important feature of Bowser Filters . . . for by hoisting the cover, to which the filter elements are attached, each element can be quickly detached for complete cleaning or inspection by removing the single tie-rod nut which holds the complete assembly together.



Flow rate is increased almost double . . . and floor space to almost half that possible with single type elements. The unfiltered water flows from inside out . . . and outside in as shown by the arrows . . . the clean water flowing into the 3/8" channel and thence to the discharge manifold header.



Bowser Diatomite Filters are popular because they only require from 1/10 to 1/5 the floor space needed by conventional filters to produce an equivalent flow of clean water.

SIZES & CAPACITIES . .

FIGURE NUMBER	FILTER AREA (SQ. FT.)	FLOW RATE AT 2 G.P.M.	NO. OF FILTER ELEMENTS
610-42	42	85	7
610-79	79	160	13
610-104	104	210	13
610-200	200	400	25
610-248	248	500	31

COMPLETE ENGINEERING DATA ON REQUEST

Engineers and Pool Operators are invited to write for complete data for replacement or new installations, or to improve present conventional facilities.

BOWSER ESTABLISHED 1885

Write today for Bowser's illustrated booklet:

"THE MODERN WAY TO FILTER SWIMMING POOL WATER."

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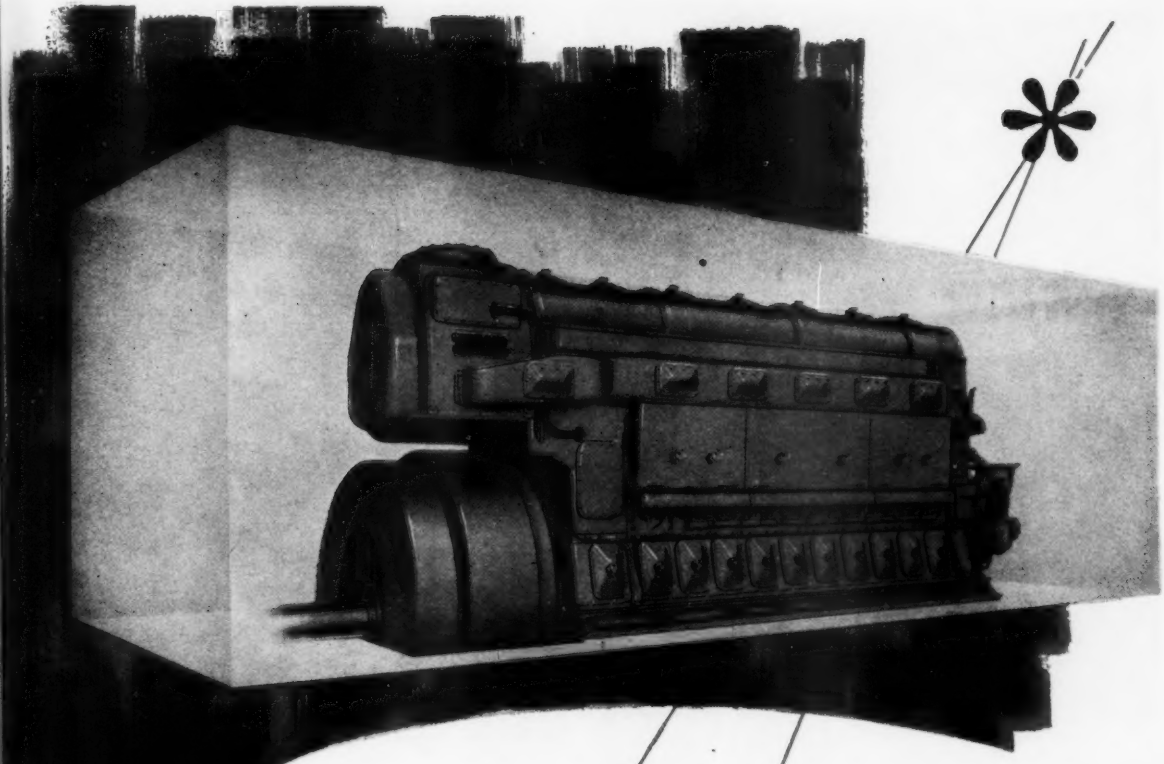

THE FAIRBANKS-MORSE MODEL 38 O.P. ENGINE

More Power *PER FOOT OF FLOOR SPACE!*

Consider this: a single Fairbanks-Morse Model 38 Opposed-Piston engine can put up to 1600 horsepower to work for you *in almost half the floor space required by other heavy-duty Diesel engines of the same horsepower.* Doesn't this suggest a way to gain that added kw-h output without remodeling or expanding your present plant floor space facilities?

The Model 38 Offers Basic Advantages of Opposed-Piston Design

Two pistons in each cylinder. No cylinder heads, no valves . . . a minimum of moving parts . . . less weight . . . more power per foot of floor space—*more economy in sustained heavy-duty service!*

For Diesel Power...

FAIRBANKS-MORSE

A name worth remembering

DIESEL LOCOMOTIVES • DIESEL ENGINES • STOKERS • SCALES • MOTORS • GENERATORS
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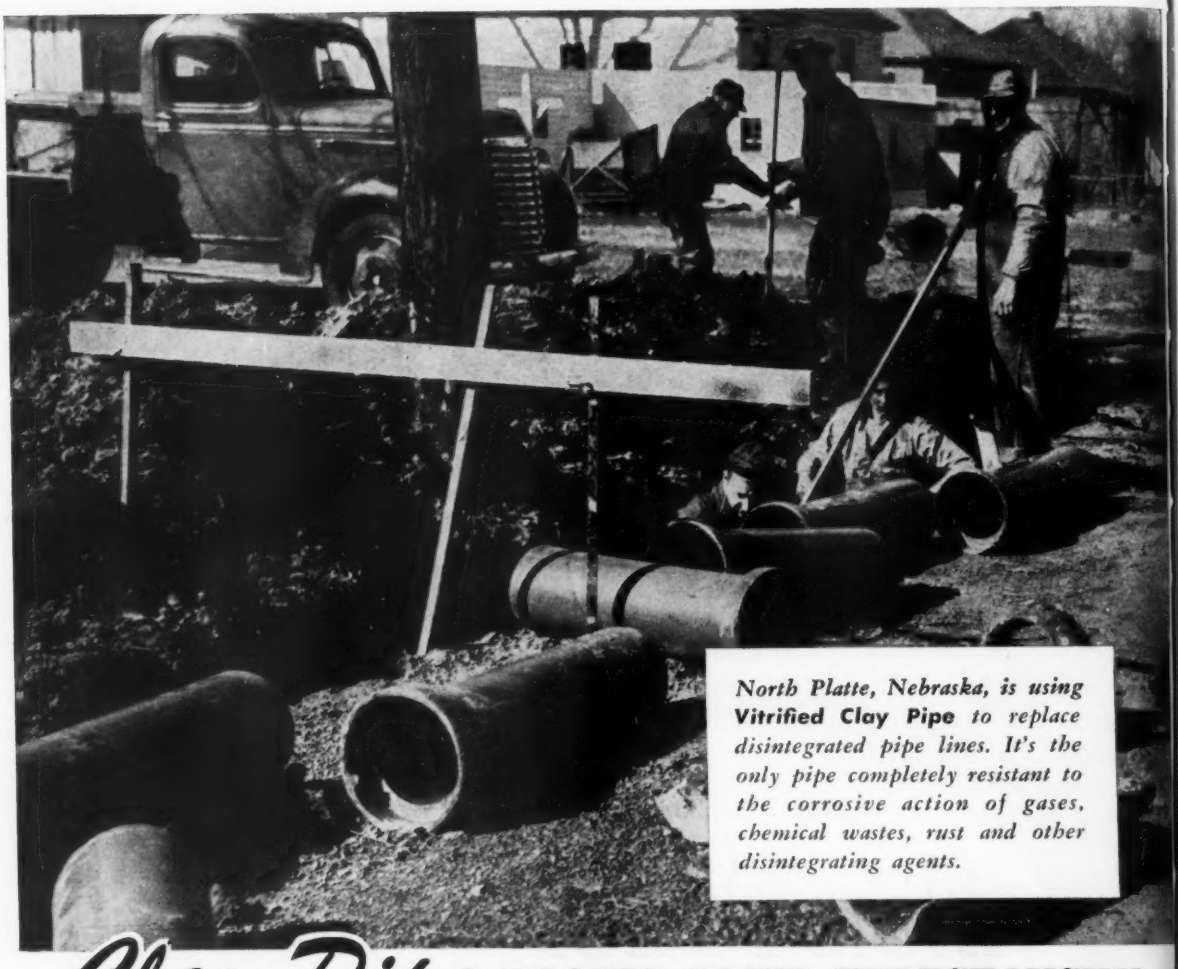
When you need special information—consult the READERS' SERVICE DEPT. *on pages 85-88*



North Platte, Nebraska, is using **Vitrified Clay Pipe** *to replace disintegrated pipe lines. It's the only pipe completely resistant to the corrosive action of gases, chemical wastes, rust and other disintegrating agents.*

Clay Pipe BOOSTS "LIFE EXPECTANCY" OF MUNICIPAL SEWER LINES

HUNDREDS of communities have found that *it pays to use the best* in sewerage installations. Thousands of dollars of taxpayers' money have gone "down the drain" for expensive maintenance and costly replacements for municipal disposal lines. That's why so many far-sighted city officials and industrial engineers are insisting on the use of Vitrified Clay Pipe to increase the "life expectancy" of municipal sewerage installations. They know that *there is no single instance on record where Clay Pipe has ever worn out.*

If you need specific information on a Clay Pipe problem, write the details to the office nearest you.

NATIONAL CLAY PIPE MANUFACTURERS, INC.
703 Ninth and Hill Building, Los Angeles 15, Calif.
1105 Huntington Bank Building, Columbus 15, Ohio
522 First National Bank Building, Atlanta 3, Ga.
100 N. LaSalle Street, Room 2100, Chicago 2, Ill.

C-548-3

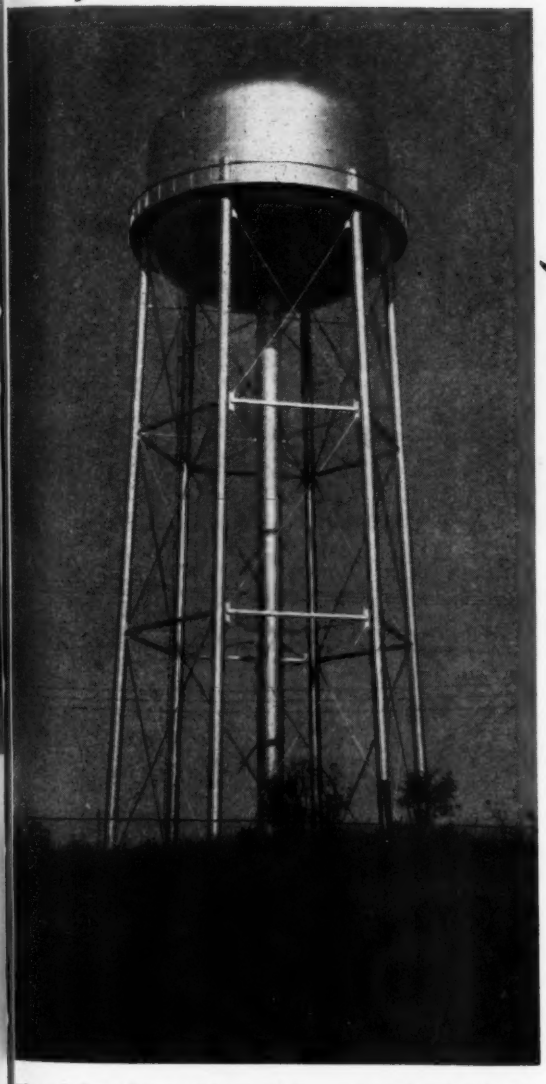
Vitrified

CLAY PIPE NEVER WEARS OUT!

CLAY PIPE

Another HORTON TANK

in Municipal Service



The tank shown here is a 250,000-gal. Horton elevated tank 94 ft. 8 in. to bottom erected in Eau Claire, S. C., a town of 10,000 population. The water system, which has approximately 20 miles of distribution mains, serves 1,400 customers who use about 400,000 gallons daily.

250,000-gal. Horton Elevated Tank furnishes gravity water pressure in Eau Claire

Horton elevated water tanks have been erected to "round out" the water systems of many municipalities in installations similar to the one at Eau Claire, S. C. Elevated water tanks provide dependable gravity pressure which makes it possible to maintain uniform pressures in water mains when pumps are shut down or are out of service in an emergency. They also provide an economical means of meeting peak loads in a water system, and are especially useful where the rate of consumption varies widely. With elevated storage, the water intakes, pumping equipment, filtration units, and transmission mains can be designed to meet average needs, with the reserve in the tank providing additional water during peak periods. Horton elevated tanks are built with capacities up to 2,000,000 gallons. Write our nearest office for details.

HORTON

STEEL STORAGE TANKS
...for municipal service

CHICAGO BRIDGE & IRON COMPANY

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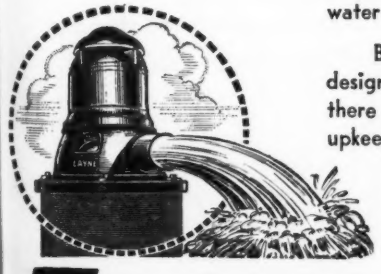

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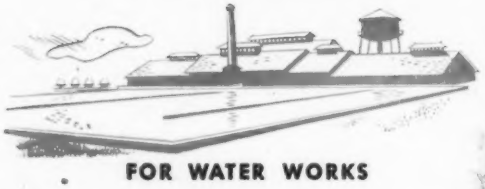

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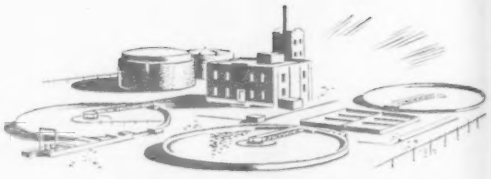

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New Bulletin No. M-52 giving details and specifications on the Gar Wood Utility Crane is just off the press. Ask your nearest Gar Wood Distributor or Branch for a copy or write directly to us at Wayne, Michigan.

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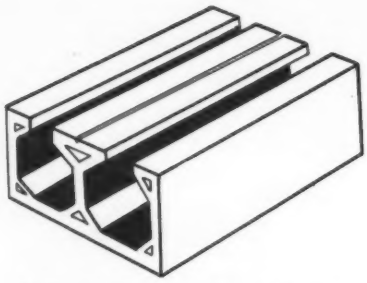
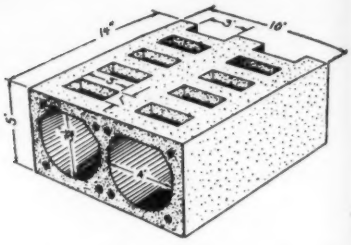


Mono-unit type Metro filter floor system



14" Armcre block made by Bowerston

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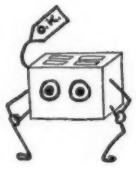

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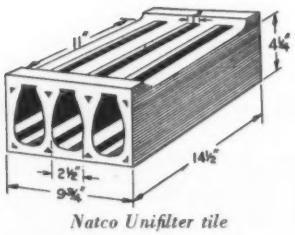
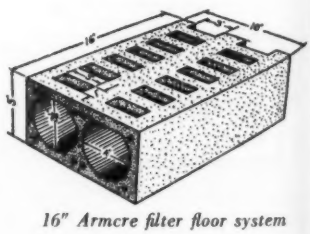


Natco Unifilter tile



16" Armcre filter floor system

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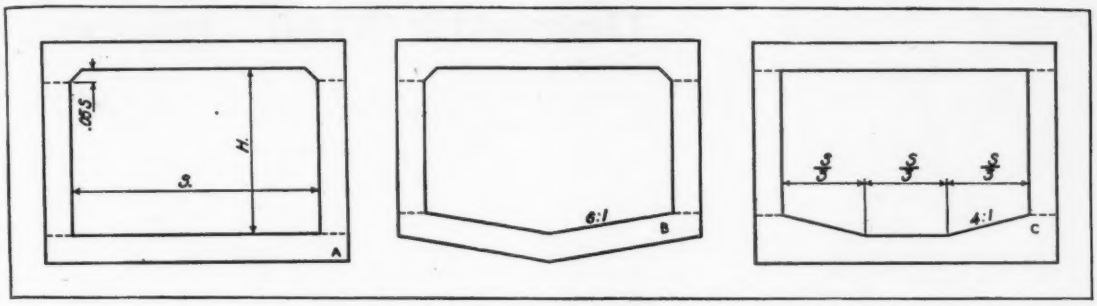


California standard culvert inverts, left to right, flat, V and trapezoidal.

California Highway Construction and Maintenance

SEVERAL items of general interest to other State highway departments are found in the 1947 report of the Director of Public Works of that state, relating to features of road construction and maintenance. Incidentally it was reported that, although there has been a rapid rise of most highway costs since the end of the war, the cost per cu. yd. of grading has changed very little, since it requires a minimum of labor and larger and speedier grading equipment has been developed.

Pavement Bases and Subgrades—All subgrade soils that may be unable to withstand the pumping action of traffic under wet conditions are being treated with either asphaltic road oils or Portland cement. Laboratory tests determine the type of treatment to be used.

Cement treatment has been used extensively to improve the quality of pavement foundations. Recent field trials have been made with exceptionally low cement contents, as little as one-half of 1 percent having been added to the foundation soils with a resulting doubling of the bearing ratio for that soil. Series of samples taken from the road mix, where traveling mixers were used, to determine the accuracy of distribution of such small quantities of cement indicated a high degree of uniformity. This work opens up a wide field for the economical use of local materials for road foundations.

Portland Cement Concrete Pavements—The elimination of expansion joints in concrete pavements has been in effect for two years. Insofar as the present condition of these pavements is concerned, the results are very gratifying.

The one and one-quarter-inch depth of transverse weakened plane joints in the uniform eight-inch depth of slab have proved to be insufficient to insure crack control, and the depth has been increased to two inches. A forming strip that remains in the pavement is now being required, the contractor having the option of furnishing metal, wood, or preformed mastic.

Culvert Standard Designs — The Division of Standards has been revising its standard culvert designs, and those for arch culverts are in final form. The standard arches are three-centered, semi-ovaloid barrels over floating parabolic invert slabs. Shapes are geometrically similar for spans of 6 to 22 feet, with waterway heights equal to 95 percent of the span and waterway area equal to 75 percent of the square on the span. The largest section has a gross waterway of 363 and rated waterway of 257 square feet. Nominal design overfill is from a minimum depth equal to the span to a maximum depth of 60 feet, but the standards are readily adaptable to greater overfills.

The standard boxes use simple design for spans of 2 to 4 ft. and rigid design for spans of 5 to 12 ft. Edges are rounded at the end of the culvert to improve hydraulic qualities.

A considerable amount of asphalt subsealing was done in 1947. In this work it was found advisable to use air-blown asphalt with a penetration of 10-25 and melting point of 200°-225°. Using 300-gallon asphalt kettles, the cost of drilling and filling each hole is about $3 per hole. The cost has been reduced to $2.50 or $2.75 per hole by use of two special tanks equipped with flues and heating equipment.

Radio Communication—The use of radio communication as an aid in highway work was first used by the California Division of Highways in 1938. At the time, five low-frequency land stations and nine low-frequency mobile units, with limited permissible use, were installed in Northern California for use in connection with snow removal. Since that date the radio system has grown to 26 land stations and 52 mobile units.

Through efforts of a Radio Committee of the American Association of State Highway Officials, the Federal Communications Commission has recognized the importance of short wave radio for highway work and has lifted the special emergency restriction under which the Division of Highways was licensed. Plans have been developed for an expanded use. Applications are now pending for 14 land stations and 20 mobile units.

Small bulldozer compacts backfill in trench.

Twin Industrial Waste and Domestic Main Sewers

CHAS. P. MARTIN
City Engineer, San Leandro, Calif.

THE conclusion of World War II found San Leandro, primarily a residential city of 28,000 population, in the path of the large industrial expansion along the east shore of San Francisco Bay. The trunk sewers and the primary sewage treatment plant built in 1939 were already becoming inadequate for the domestic wastes of the city and certainly would not handle the industrial wastes anticipated. Therefore, a bond issue of $267,750 was voted in 1945 for constructing a new interceptor sewer and making additions to the sewage treatment plant. New developments in the industrial area and rising construction prices caused a review of the preliminary plans and another bond issue for $900,000 was voted. With adequate funds available, the development of the industrial area, as well as relief to the rest of the city, became feasible.

Fortunately the potential industrial areas to the south and west of the city had not as yet been sewered. Therefore, there were no combind or inadequately designed sewers to replace or modify except the main trunk sewer leading to the disposal plant from the developed portion of the city. We were in practically "virgin ground" and could design properly the sewerage system to meet a planned development.

Design of the system was further made easier by the fact that only a definite area need be served; no provision for intangible future development was necessary. This was due to the fact that the city of Oakland sewerage system bounded us on the north and east and the Oro Loma Sanitary District system on the south. Thus the ultimate industrial development and the ultimate population growth could be quite accurately forecast.

Bases of Design

With these design factors adequate construction funds and the possible use of sewer rentals to maintain sewerage facilities, the following conclusions were reached: Separate sewers for domestic and industrial wastes would provide economic advantages; if it became necessary to institute a sewer rental program in San Leandro the problem of basing the charges could be handled in a more equitable manner. Residential use could be based on a flat rate while large industrial use could be based on quantity, BOD load or any other method found necessary. With funds available for reconstructing the treatment plant, the treatment processes necessary for the industrial wastes and the domestic sewage could be separated, thus again adding flexibility, as well as economy. Therefore, designs were made and plans and specifications prepared embodying the following features: Twin main domestic and industrial sewers from the sewage disposal plant to and throughout the industrial area; domestic mains to the developed area of the city to intercept existing sewers; separate treatment for industrial wastes and domestic sewage in the treatment plant; and final discharge of the effluent from the plant into a storm sewer outfall and thence to the waters of San Francisco Bay.

Construction Procedures

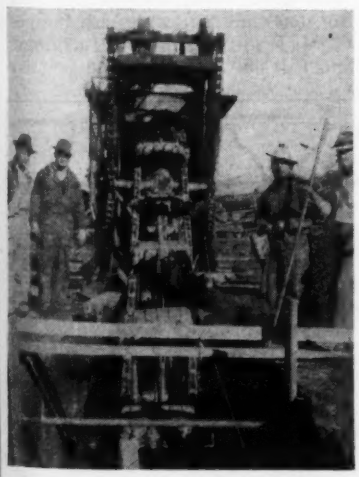
Contracts for the main trunk sewers leading to the treatment plant, which would replace the existing inadequate main, and the pumping unit of the treatment plant were awarded in September, 1946. Additional units of the twin sewers have subsequently been contracted for and work is now in progress on some of the final sections. The contract has been awarded and the work is now in progress on the remainder of the sewage treatment plant.

The twin sewers were laid in the

Trencher takes out center of trench; clam shell the rest.

Aerial view of San Leandro industrial area.

same trench allowing only enough space between the sewers to backfill properly around them. Reinforced, centrifugally-cast tongue-and-groove concrete pipe was used in sizes from 36-inch to 15-inch. Jointing was with cement mortar. Water was encountered in the trench throughout the lower sections of the job. Dewatering was accomplished by pumps placed at 300-foot intervals along the trench. Trenches were excavated six inches below the grade of the bottom of the pipe and a coarse rock mat placed in the bottom of the trench to carry the pipe. Select backfill material consisting of quarry dust, sand or other available material was compacted around the pipes to above the spring line. At the lower end of the job where the larger pipe sizes were used, trench excavation was accomplished with a dragline cutting a sloping side trench.



Parsons trencher cuts 6½' wide with side cutters.

No shoring of the trench was necessary except for a distance of approximately 500 feet. In this section the sewer line crossed an ancient stream bed where quicksand and gravel were encountered. Through this section, steel sheet piles were driven on four-foot centers on each side of the proposed trench before excavation was commenced. Each pair of piles (one pile for each side of the trench) was driven at the same time by a special pile driver designed for this job; 50 ft. of double sheet piling could be driven in a day. The excavation through this section was accomplished with a trenching machine which took out the center 3 ft. and the remainder of the excavation was made with a clam shell. As the excavation progressed, trench jacks were placed between the pairs of piles and additional timber shoring placed to hold back the unstable material.

Crossings under railroad tracks were made by jacking corrugated iron culvert pipe through and placing the concrete pipes inside the culvert pipe. The space between the concrete pipes and the interior of the culvert pipe was filled with sand.

The section of twin 21-inch sewers now under construction is being excavated with a Parsons trencher, modified with side cutters mounted on the boom to excavate a vertical side trench 6½ ft. wide. The machine cut an average of 100 feet per day to an average depth of 20 feet. Shoring of this trench is necessary on 8-foot centers. Backfill of this trench is made with a crawler type D-2 Caterpillar bulldozer weighing 4½ tons which spreads and compacts the earth in 8-inch lifts. The bulldozer works on an incline in the trench, continually drifting the backfill ahead as more earth is pushed into the trench by a bulldozer on the surface. By backing up to the surface and then running back down into the trench carrying a cut of earth ahead of it, the bulldozer spreads and compacts the earth in thin lifts.

Manholes are rectangular reinforced concrete boxes covering both sewers and providing diversion channels for future sewers entering laterally. No steps are provided in the manholes in order to prevent unauthorized persons and children from climbing in. Sewer maintenance crews use a ladder to service the sewers.

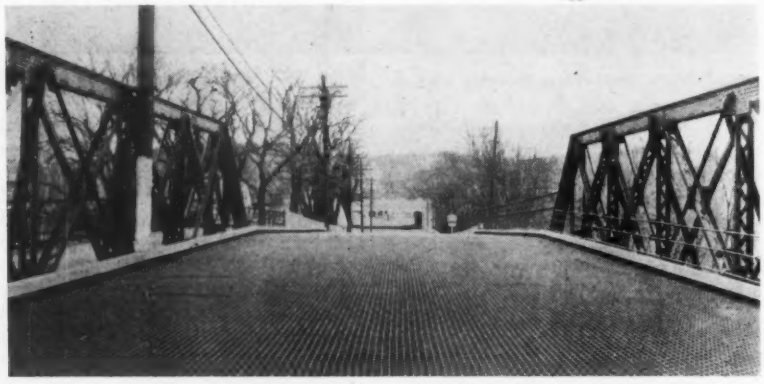
The people of San Leandro feel that the installation of twin sewers which will result in the development of their industrial areas and the relief of their inadequate domestic sewerage system has been a good investment.

Open-Grid Floors for Bridges

RICHARD J. BARRY

Selection of proper strength material and step-by-step procedures in construction are outlined in this article designed for county, city and township engineers and superintendents.

THE first installation of an open steel grid floor for a highway bridge roadway was made on the University Bridge, Seattle, Washington, more than 15 years ago. During the service test to which it has been subjected in the decade and a half that it has been in use, this floor has been most satisfactory in regard to safety, durability and economy. There have been no skidding accidents; neither have any repairs, replacement or other maintenance been necessary—not even painting of the decking. Moreover, since this floor was placed on the University Bridge, there have been four other bridges in Seattle floored with the same material. Similar installations have been made on hundreds of other bridges throughout the United States, including short and long fixed spans, single and double leaf bascules, and the world's largest highway vertical lift span.



Grating was used on this Millbury, Mass., bridge.

The University Bridge, which is typical of the many mentioned above, and well illustrates standard procedures, was floored with Irving Decking. This consists of alternate 2½-inch by 3/16-inch bearing bars, spaced 2½ ins. on centers, and 1½-inch by 3/16-inch bracing bars riveted at points of contact on 5-inch centers. The top edges of all bars are flush. Construction procedures are shown in the accompanying illustrations. This decking is shipped to the job site in standard units 25 ft. long and 2 ft. 6 ins. wide. Special end and side units of proper dimensions to fill out to the exact overall length and width are provided.

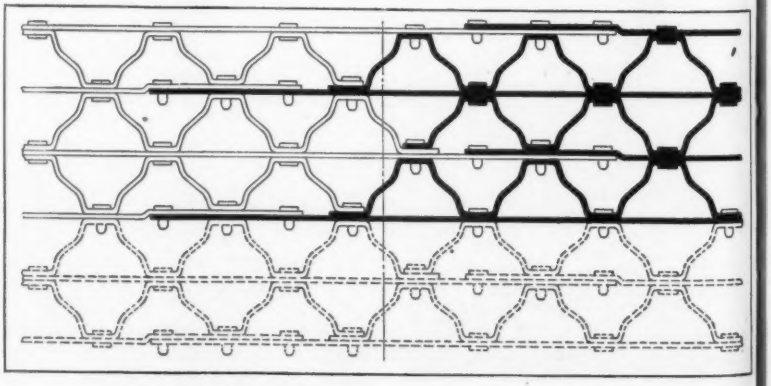
Such decking, which weighs only 15.25 pounds per sq. ft. for standard highway loading, is suitable for all types of bridges, both rural and urban. Installation can be made in any weather. Time of construction is markedly reduced, and the labor needed for such construction is also reduced. The procedures in laying are illustrated, step-by-step, in the accompanying illustrations.

The decking units are provided with means for quick and easy end- and side-splicing in the field. The splice consists, essentially, of overlapping end bars having concentric holes through which rivets are inserted and then headed with tools provided by the manufacturer. The laying of units, lining up of holes, inserting and heading of rivets are all simple and can be accomplished with unskilled labor. When completed, a one-piece continuous open steel grid pavement is provided, free from seams, cracks or surface unevenness of any kind.

It is better to lay the open steel grid bridge flooring with the bearing bars parallel to the line of traffic. It has been found that side-skidding tendencies are much reduced when this method is used as compared to placing these bars at right angles to the line of traffic. Also, bars of 3/16-inch thickness are safer than thicker bars, since the thicker bars are less non-skid. Service under traffic for more than 15 years has shown no decrease in the thickness or depth of the 3/16-inch bars originally installed, and therefore this thickness is considered ample.

The decking is usually laid on and welded to transverse sills, usually I-beams or channels. These sills are spaced at the distances shown in the "Safe Load Table" for given loads. The section of the sills required for the various spacings of stringers on which they rest and to which they are welded is shown in the accompanying "Table of Required Transverse Sills for Varying Loads and Stringer Spacings."

In addition to safety and freedom from maintenance, such bridge decking has the following advantages: (1) It is self-cleaning, self-draining, and will not float—an important fac-



Solid lines show end splicing; dotted lines show method of side splicing.

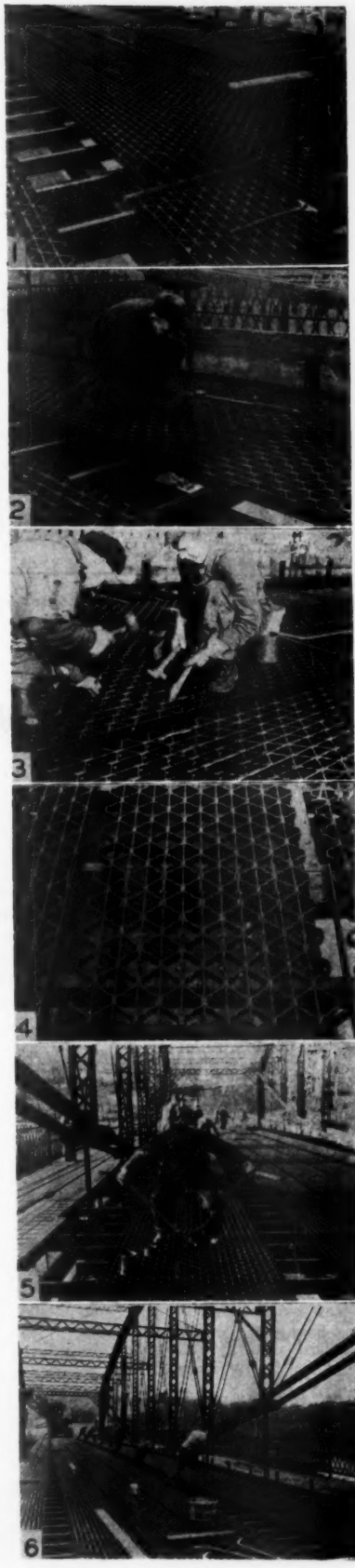
tor in flood areas. (2) It has permanent smoothness and built-in traction, and therefore reduces vibration and impact stresses to a minimum. (3) Sun and air pass through it readily, drying the supporting members and eliminating or retarding corrosion. (4) It may be used immediately after laying. (5) Its light weight permits a reduction in the cost of the supporting structure (as much as $250,000 in the case of the Brooklyn-Queens Marine Parkway Bridge) and has made possible the addition of wings for extra traffic lanes without strengthening the bridge. (6) In the case of bascule bridges, the leaves when using 80% open grid floor, offer practically no resistance to and and are not affected by horizontal winds; and vertical winds will not affect dangerously long fixed spans floored with open grid decking.

The methods of construction shown in the illustrations herewith are applicable to all types and sizes of bridges, whether for cities, counties, townships or states.

SAFELOAD TABLE

Loading	Span
H-20	18″
H-15	19″
H-10	20½″

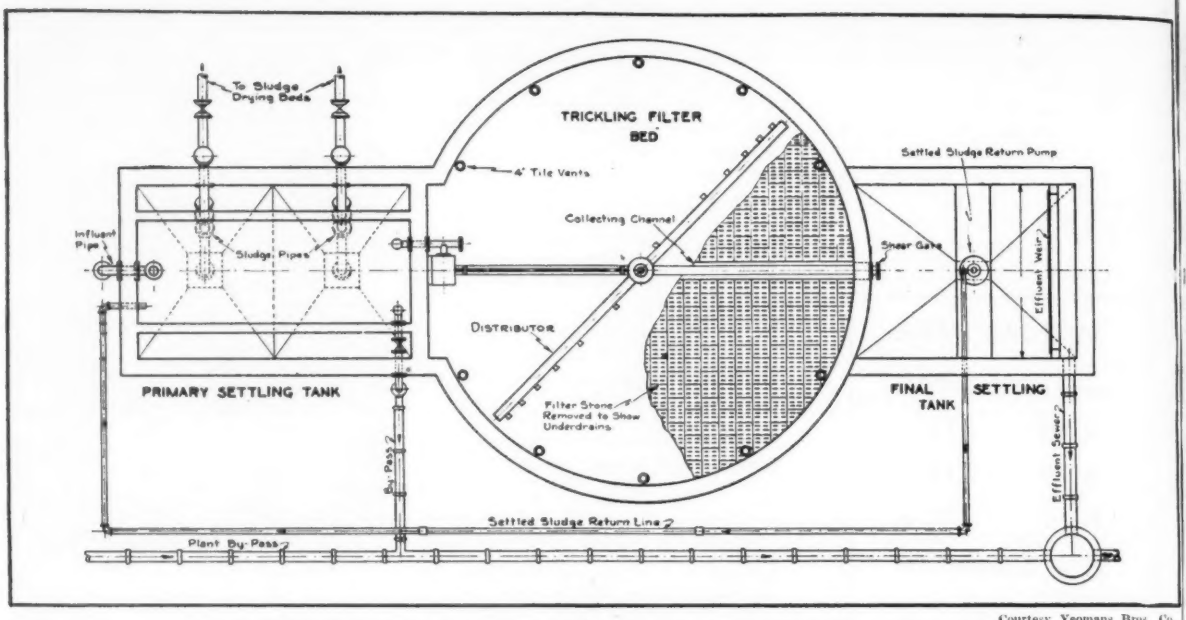
30% Allowed for Impact.



Bridge floor construction proceeds as shown in pictures at right. Units are rolled into place (1); tapped level (2); rivet holes lined up (3); and rivets placed (4); and then headed with squeezing tool loaned by manufacturer (5). Curb-side units are spliced about three feet from curb to allow working room and then eased over to curb (6). Below, sill and stringer spacings are shown in tabular form.

TABLE OF REQUIRED TRANSVERSE SILLS FOR VARYING LOADS AND STRINGER SPACINGS.

Design Conditions	1. Allowable Stress 18,000#/sq. in. 2. Impact 30% 3. Continuity Coefficent 80% 4. Wheel Load 50% (The design for shear and buckling is governed by 100% wheel load)						
Maximum Transverse Sill Spacings—H-20, 18′; H-15, 19′; H-10, 20½′							
Transverse Sills		Loading H-20		Loading H-15		Loading H-10	
Channels		Stringer Spacing		Stringer Spacing		Stringer Spacing	
Depth	Weight	From:	To:	From:	To:	From:	To:
3″	4.1#	.....	.....	.....	.....	2′-0″	2′-2⅜″
3″	5.0#	.....	.....	.....	.....	2′-2⅜″	2′-4⅛″
4″	5.4#	2′-0″	2′-2″	2′-0″	2′-8″	2′-4⅛″	3′-2⅞″
4″	6.25#	2′-2″	2′-6½″	2′-8″	2′-10⅛″	3′-2⅞″	3′-7⅛″
5″	6.7#	2′-6½″	2′-10⅛″	2′-10⅛″	3′-8⅜″	3′-7⅛″	4′-4¾″
6″	8.2#	2′-10⅛″	4′-1⅛″	3′-8⅜″	4′-11″	4′-4¾″	6′-8″
7″	9.8#	4′-1⅛″	5′-3½″	4′-11″	6′-6″	6′-8″	9′-0″
8″	11.5#	5′-3½″	6′-9½″	6′-6″	8′-6″	9′-0″	10′-0″
9″	13.4#	6′-9½″	8′-6″	8′-6″	10′-0″	.....	.....
9″	15.0#	8′-6″	8′-10⅛″	.....	.....	.....	.....
10″	15.3#	8′-10⅛″	10′-0″	.....	.....	.....	.....
Transverse Sills		Loading H-20		Loading H-15		Loading H-10	
I Beams		Stringer Spacing		Stringer Spacing		Stringer Spacing	
Depth	Weight	From:	To:	From:	To:	From:	To:
3″	5.7#	.....	.....	2′-0″	2′-1½″	2′-0″	3′-0½″
3″	6.5#	2′-0″	2′-3″	2′-1½″	2′-6½″	3′-0½″	3′-2⅜″
3″	7.5#	2′-3″	2′-5¾″	2′-6½″	2′-8″	3′-2⅜″	3′-3⅞″
4″	7.7#	.....	.....	2′-8″	3′-1¾″	3′-3⅞″	4′-10½″
4″	8.5#	2′-5¾″	3′-1¾″	3′-1¾″	3′-11″	4′-10½″	5′-1¾″
4″	9.5#	3′-1¾″	3′-4½″	3′-11″	3′-11⅝″	5′-1¾″	5′-3½″
5″	10.0#	3′-4½″	3′-7⅛″	3′-11⅝″	5′-4¾″	5′-3½″	7′-4⅛″
5″	12.25#	3′-7⅛″	4′-10¾″	5′-4¾″	5′-11⅜″	7′-4⅛″	8′-2⅜″
6″	12.5#	4′-10¾″	6′-3″	5′-11⅜″	7′-9¼″	8′-2⅜″	10′-0″
6″	14.75#	6′-3″	6′-7¾″	7′-9¼″	8′-3½″	.....	.....
7″	15.3#	6′-7¾″	8′-5″	8′-3½″	10′-0″	.....	.....
8″	17.5#	8′-5″	10′-0″	.....	.....	.....	.....



Courtesy Yeomans Bros. Co.

A small trickling filter installation, consisting of an Imhoff tank, a rotary distributor, and a secondary settling tank. Equipment for these is available for flows as small as 1000 gals. per day.

Small Sewage Treatment Plants

VI—Trickling Filters

The requirements and suggestions of various State Departments of Health in regard to design of trickling filters for sewage treatment are presented in this article. It is one of a series intended to help solve the problems of the more than 9,000 small communities reported by the Public Health Service as being in need of sewerage facilities.

ALL filters should be followed by adequate provision for settling the filter effluent. However, in this article, secondary settling tanks will not be considered, and the design of filters will be considered in a later article, with suggestions covering certain details of design. Because of the difficulty in showing clearly the various state requirements in tabular form, required or recommended practices are grouped together under appropriate headings.

Low Rate Filters

Loadings.—There are three principal methods of indicating loadings—amount of BOD, volume of sewage flow, and population. Colorado, Connecticut, Idaho, Illinois, Kansas and Tennessee use BOD loading as the primary measure and recommend 400 lbs. per acre-foot. Florida permits 600 pounds; Ohio, 538 pounds; Texas, 450 pounds; and South Dakota 250 pounds. The low loading in the latter state is explained by W. W. Towne, Director of the Division of Sanitary Engineering, as follows: "Due to the general lack of dilution for sewage plant effluents in this state, we are quite conservative in our trickling filter loadings. Many of our plants discharge into entirely dry watercourses . . . and in the event the effluent is not stable, complaints are sure to arise."

Volume loadings are stated as follows: Alabama, 300,000 to 400,000 gallons per acre-foot per day; Connecticut, 300,000; New York, 300,000; South Dakota, 200,000 to 250,000; and Tennessee, 400,000. Population loadings are as follows: Colorado, Connecticut, Idaho and Iowa, 3,500 persons per acre foot; New Mexico, about 3,600; and Wisconsin, 3,000.

Depth. — Requirements or recommendations for depth of low rate filters are: Alabama, not less than 6′ nor more than 10′; Colorado, 5½′ minimum and 7′ maximum, unless greater depth is justified by exceptionally strong applied sewage; Connecticut, 6′ minimum and 9′ maximum; Idaho, same as Colorado; Iowa, 7′ minimum; Kansas, 6′ minimum; New York, 6′ to 10′; South Dakota, 6′ minimum and 8′ preferred; Tennessee, 6′ minimum and 8′ maximum; Texas, 4½′ minimum 7′ maximum; and Wisconsin, 5′ minimum.

Media.—New York and Connecticut suggest 1″ to 2½″ stone for trickling filters; Alabama, 1″ to 3″; Colorado and Idaho, 1½″ to 2½″; South Dakota, 1½″ to 3″; and Texas 1½″ to 3½″. Freedom from dust and fine material is uniformly required, and compliance with the sodium sulfate soundness test is specifically mentioned by Alabama, Colorado, Connecticut, Idaho and Kansas (20-cycle rock for top 3 ft., remainder at least 10-cycle rock).

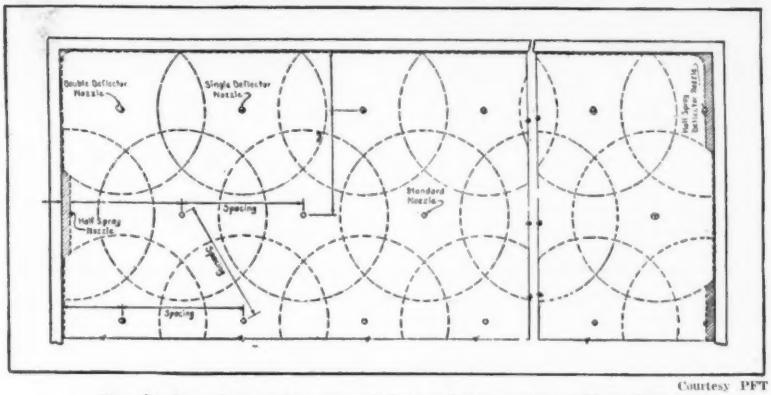
Underdrainage and Ventilation.—Nearly all states recognize the importance of adequate underdrainage and ventilation. Alabama says: "Provision must be made for ventilating, flushing and draining . . ." Other statements include: Colorado, "adequate underdrains of a type designed for this usage . . ."; Idaho, the same; New York, "proper ventilation and adequate drainage"; South Dakota, "the underdrainage system should be sufficiently large so that at maximum flows it will not be flooded and ventilation through the media will be adequate"; Texas, "proper ventilation and adequate underdrainage should be provided, with provision for flooding and chlorination if odor or fly nuisances are likely." Many other states have provisions requiring methods for fly control.

Comment and Design Data

For low rate filters, the average required or recommended loading is about 400 lbs. of BOD per acre-foot; the usual volume loading is 300,000 gallons per acre-foot per day; and the population 3,500 persons per acre-foot. The first two requirements harmonize quite closely. Assuming a 33% removal of BOD in the primary tank and a raw sewage content of 250 ppm BOD, a loading of 300,000 gals. per day per acre-foot equals 416 lbs. of BOD. On the other hand, 3,500 persons at 0.166 lb. of BOD per person, which is the commonly accepted figure, equals a loading of 583 lbs. per acre-foot.

Example 1.—Assume that a plant must be designed to serve a population of 1,000, the volume of sewage not being known. This is a frequent condition with small plants, and the population figure will therefore be used as the design basis. The area required for 1,000 persons will be 1,000÷3,500, or 0.286 acre-foot. If a filter depth of 6 ft. is assumed—a good depth for the low-rate filter plant—the surface area of the filter will be 0.048 acre or 2,090 sq. ft. This is equivalent to a circular filter 52 ft. in diameter, or a rectangular filter approximately 40′ by 52′. The circular filter will require a rotary distributor and the rectangular filter will use fixed nozzles.

Information on design details for low rate filters will appear in the next article in this series. Such details will include the design of the filter floor in regard to underdrainage, effluent channels and ventilation; the walls, filter dosing tank and head losses. As will be indicated, the manufacturers should be contacted at an early stage so as to assure that proper head is allowed for the distributor or the nozzles.



Courtesy PFT

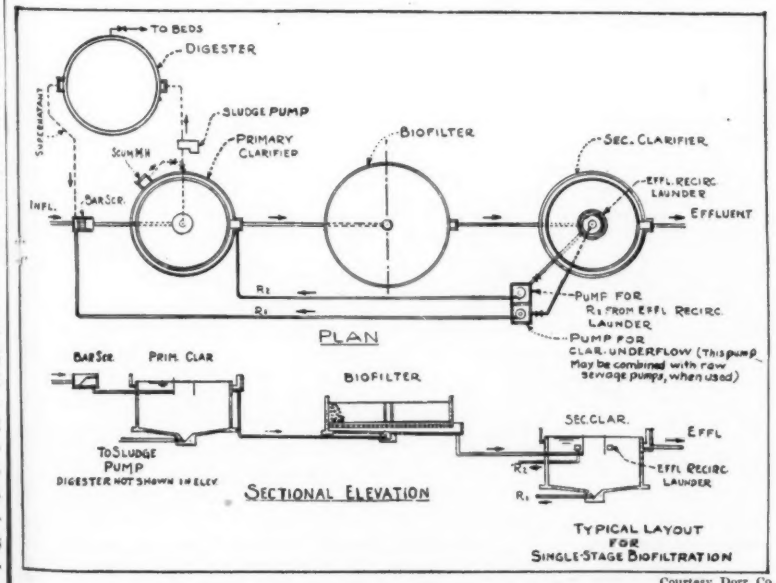
How fixed nozzles can be arranged for small rectangular trickling filters.

For a smaller filter, design will follow the same steps. Assume 350 persons; 0.10 acre-foot will be required, and if the filter is 6 ft. deep, the dimensions will be about 31 ft. in diameter, if round; and about 22′ by 33′, if square. In this case, and in fact in many cases, a slight depth adjustment may be made to permit a standard dimension rotary distributor, as 30 ft., or the most effective spacing of spray nozzles for the rectangular unit.

Distributors so small as to be suitable for only 12 to 20 persons are available from at least one manufacturer; and most of the makers can supply distributors from 15 ft. in diameter up. Spray nozzles can be designed for small installations also.

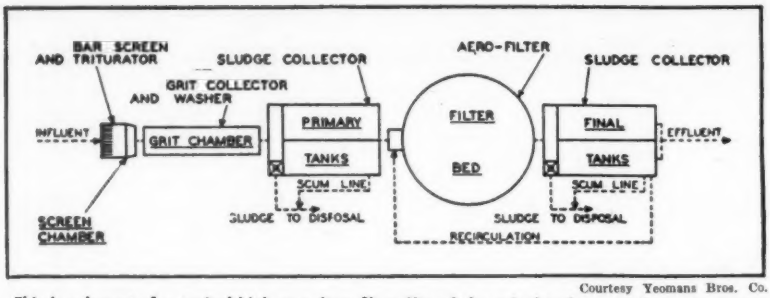
Expected Degree of Treatment

With the design bases established above, very good results will be obtained from trickling filters when followed by properly designed secondary settling tanks. The effluents from such plants should not contain more than about 30 ppm. of BOD, though some plants will be higher and some lower. A good discussion of these factors, and a summary of results of various studies will be found in *Public Works Magazine* for April, 1947, and in Chapter 3 of the Trickling Filter Handbook, the data being identical in each. If a higher degree of purification is required to prevent nuisance, some additional treatment, as slow or high-rate sand filters, must be provided. In many cases, a more generous design basis will provide a better effluent, though this is not always the case. At any rate, the effluent from a low-rate filter is quite stable and with a reasonable degree of dilution will be satisfactory. The State Sani-



Courtesy Dorr Co.

This shows a layout and a section through a small high rate shallow filter.



Courtesy Yeomans Bros. Co.

This is a layout of a typical high-rate deep filter. Use of the grit chamber may be unnecessary on a small plant.

tary Engineer should always be consulted.

High Rate Filters

Few states, as yet, have adopted standards for high rate filters, most of them preferring to consider each case on its own merits. Colorado provides that the rate of loading on biofilters shall not exceed 2.5 lbs. of BOD per cubic yard of stone per day, based on the strength of the primary effluent applied to the filter; depth of stone shall be not less than 3 ft. Florida permits a loading of 3,000 lbs. of BOD per acre-foot. It is not stated if this is on the basis of raw or settled sewage, but it is probably on the former basis. Further, Florida recommends a dosing rate of 20 mg. per acre per day, and establishes a minimum dosage rate of 12 mgad. Idaho recommends a dosage rate of 16 mgad but does not fix organic loadings. Texas permits either the shallow or the deep type of high rate filter, and fixes the maximum loading at not in excess of 1.25 lbs. of BOD per cubic yard or about 2,000 lbs. per acre-foot. This presumably applies to settled sewage.

Example 2.—For a population of 1,200 persons, the expected BOD at the rate of 0.167 lb. per person per day will be 200 lbs. On the commonly accepted basis of 3,000 pounds of raw sewage BOD per acre-foot, there will be required 200÷3,000, or 0.067 acre-foot or 108 cu. yds of filter media. If the filter is 3 ft. deep, the area will be 972 sq. ft. and the required diameter for a circular filter will be 35 ft. If the filter is 6 ft. deep, the required area will be 486 sq. ft., and the diameter about 25 ft.

There are many variations in layouts of high rate filters, providing for economical layout to meet very many conditions. These may depend on the amount of head available: In some cases a shallow filter, say 3 ft. deep. will eliminate the need for pumping or prevent danger from flooding by high water; in other cases, a deeper filter, with its smaller surface area may be advantageous. Even the shallowest filter will require a loss of head through the plant of approximately 6 ft. from influent to effluent; in other words, for a rough rule, add not less than 3 ft. to the depth of the filter to determine the operating head necessary at a small installation. More is preferable. This loss of head will include that through the dosing tank and distributor, through the filter, that due to the underdrains and the floor slope, that required by the filter drainage channel, and the loss in the secondary clarifier.

Detailed information on the various types of high rate filters and charts showing the operating results obtained by them are included in the Trickling Filter Handbook. In general, however, it is recommended that contact be made with the appropriate manufacturer for advice and assistance in the initial design of the small plant.

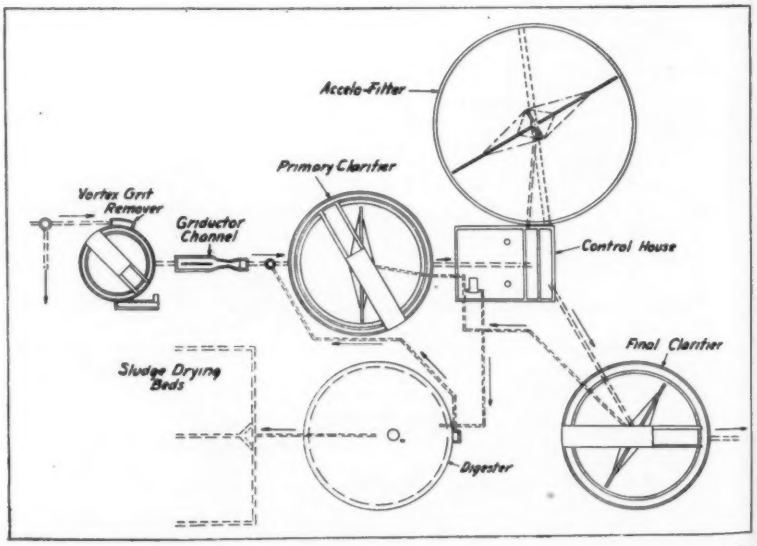
The single-stage high rate filter will not produce an effluent as low in BOD or as stable as the lightly loaded low-rate filter will produce. However, in many cases, a fully satisfactory degree of treatment can be obtained. If a high degree of treatment is desired, a two-stage plant may be necessary,. which type of plant can be designed to give almost any desired degree of treatment.

High rate filters require recirculation, some of them all of the time, others part of the time. This necessitates electrically driven pumps. The head pumped against is low, however, and the power required is not great.

In two-stage filters, the same volume of filter media is used, but it is divided between a primary and a secondary filter. For instance, in the case of Example 2, above, there might be two filters, each about 25 ft. in diameter, and 3 ft. deep; or two filters 18 ft. in diameter, if 6 ft. deep.

Distributors designed for low rate filters cannot be used for high rate filters because of the difference in the rate of sewage application to the filter surface. For low rate filters the average application to the surface of a 6 ft. deep filter will be at the rate of 1.8 million gallons per acre per day, though the peak rate may be considerably higher. As indicated by the state requirements, application rates for high rate filters may range from 1 mgad to 30 mgad. For that reason, special distributors, usually with 4 or more arms are used.

In the next article in this series, details of design for small filters will be presented.



Courtesy Infilco

This layout shows another type of deep high-rate filter. On small plants the grit remover and griductor may often be omitted, but a screen is then desirable.

Waterworks Improvements at Amarillo, Texas

STANTON M. FIELD
City Engineer

AMARILLO, founded in 1887, had a population of 51,686 in 1940, which had grown to an estimated 72,000 in 1947. This rapid growth has naturally taxed the capacity of the facilities for water production, storage and distribution, and beginning in 1945 the city has been increasing each of these.

Up to that time water was obtained from 20 wells at the rate of 600,000 to 1,000,000 gpd. These wells were located along two parallel lines of 30″ pipe, one concrete and the other cast iron, extending southwest from the city. Water was pumped into these lines from the wells and then flowed by gravity into two 5 mg. concrete underground storage tanks, from which it was pumped into the distribution system. The only other storage was a 500,000 gal. elevated storage tank which floated on the distribution system.

Increasing the Supply

To increase the supply, 13 additional wells were drilled along the two existing collecting lines and are now in use. In addition, the city about a year ago voted by a large majority to issue $2,000,000 in revenue bonds for further increasing the supply, and the mayor appointed a board to study various locations as prospects for a new well field, and a thorough study was made by this board, by consulting engineers and other governmental agencies. A decision was reached to establish a new field, also southwest of the city but slightly north and northwest of the existing field. Plans and specifications were prepared by Freese and Nichols, consulting engineers, for constructing 62,000 ft. of 36″ pressure concrete pipe and bids for same were opened Nov. 25th, 1947, and contract awarded to Bell, Braden, Barker & Gilvin of Amarillo on their low bid of $745,128.80. At the time of this writing (January, 1948) the pipe was being processed and construction was expected to start about Feb. 15th. When this line has been constructed, contracts will be awarded for drilling wells to serve it.

Increasing Storage

To increase the storage capacity, three 1,000,000-gal. elevated steel storage tanks have been constructed, each at such height that its water level would be at the same elevation as that of the existing 500,000-gal. tank. Two of these are radial cone tanks built by the Chicago Bridge and Iron Co., and the third was built by the Pittsburgh-Des Moines Steel Co. Foundations were built under separate contracts by local contractors. The tanks are provided with risers 4 ft. in diameter. The range head is 30 ft. The structures are designed for a wind load of 30 lb. on a vertical plane, 18 lb. on the projected area of cylindrical surfaces and 15 lb. on conical or double curved surfaces.

One of these tanks was located in the northeastern part of the city, one in the western section, and the third in the southwestern, to furnish additional volume and pressure in those sections. The first was placed in service in the spring of 1947, the second in November, 1947, and the third was approximately 80% completed in January 1948.

Meantime plans were prepared by Freese and Nichols for a 5-mg underground concrete storage reservoir 189 ft. by 267 ft., 16 ft. 4 in. high at the edge and 18 ft. 4 in. at the center, the floor having a slope of 1 ft. and the roof a 1 ft. crown. The walls are 18″ thick at the base and 12″ at the top, with 12″ x 14″ pilasters. The roof is 7½″ thick, supported on round columns 16″ in diameter on 19′6″ centers, resting on foundations 4′6″ square and 19″ thick. The top 19″ of each column is flared to 4′6″. The entire reservoir will be covered with 18″ of dirt and sodded. An effluent valve chamber 11′4″ x 6′ extends from below the bottom of the reservoir to the natural grade. An 18″ overflow is installed for emergency.

The 1 mg. elevated tank.

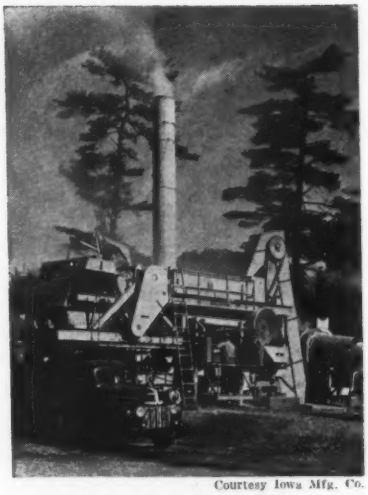
A chlorinator and stilling basin will be constructed 17′ x 47′3″ long, into which the lines from the collecting fields will extend. A building will be built above the basin to house the chlorinating equipment, approximately 17 x 28 ft. and 10 ft. high. This will be of brick; all the other construction of heavily reinforced concrete. Water will flow to this reservoir by gravity, and from it by gravity to pumps, by which it will be sent through the distribution system and to the four elevated storage tanks.

Distribution System

During the extension work described above a system of 6″ to 20″ distribution lines was laid throughout a large portion of the city connecting the three new elevated steel tanks with the existing tank and with the entire distribution system, giving the greatest amount of continuous circulation. During the war the Army had laid about 10 miles of 20″ cast iron pipe from our system to the Amarillo Army Airfield. Part of this was in the city and the balance would be of great value to it, and the city purchased this from the War Assets Administration.

Costs

Two of the three elevated tanks cost $95,625 each and their foundations $13,536.25 and $13,150 respectively. The third tank cost $115,500. The underground storage reservoir was contracted for $192,000. The cost of the new pipe line to the production field was $745,128.80.



Courtesy Iowa Mfg. Co.

Typical asphalt plant setup.

How to Build

Low Cost Roads with Today's Equi

By the Editors of Public Works

This text has been prepared primarily for the engineers and superintendents of counties, cities and townships, who are responsible for the planning, construction and maintenance of streets and highways. It discusses and describes certain types of pavements specially suited to modern-day conditions and illustrates some of the labor and time-saving equipment available for building and maintaining them.

PLANNING is important in every road job, no matter how small. There are two phases of planning, which may be classed as broad planning and detail planning. The broad phase should be based on complete data—an over-all inventory—of the county or town road system or the city street system. This inventory should (1) show the present physical condition of the surface and the base of each street or road; (2) estimate present traffic weight and volume; and (3) provide a basis for an estimation of future traffic loads. With these data at hand, a sound program for improvement can be formulated, not only for new construction but for priority on improvements.

Detail planning, as it refers to any specific road or street, should consider needed and possible improvements in width, curvature, alignment, drainage, shoulders and surface. Improvements should not be begun until all of these factors have been considered and provided for so far as is desirable or possible.

Good drainage is necessary no matter what the type of surface or weight of traffic. Both surface and subsurface water must be provided for; the first to prevent overflows, washouts, undermining and danger to traffic; and the second to insure a firm base that will, at all times, support the traffic load transmitted by the surface.

The width of the roadway, and of the bridges that carry it over watercourses, may vary according to the importance of the road and the kind of traffic it carries. Usually both pavements and bridge openings are too narrow; at least we know of many that are too narrow and recall none that is too wide. In improving an old road, every effort ought to be made to provide enough width—generally about 2 ft. wider than appears necessary will help. Likewise, curves should be opened up, if possible, and alignment improved, However, where this is difficult, extra width will help. Shoulders should be wide, well-constructed, and with a flat slope.

Equipment is available for better and cheaper construction of all of the types of surfaces and improvements described in this article. Illustrations of some of this equipment are shown in the text, special consideration being given to labor-saving type of equipment, because of the present serious problems of obtaining personnel. Many cities and counties will find it a paying investment to own equipment of the types shown; other communities, because of local conditions, may find it more desirable to rent the equipment, or to have the work done under suitable contract provisions. In any case, the work should be planned to take full advantage of such modern equipment, utilizing its ability for better, quicker and lower-cost construction.

Specific cost data are so dependent on local conditions that no attempt will be made here to discuss this factor. In general, the types of surfaces described will be "low-cost" in any community when compared to the benefits resulting from their construction.

Plant Mixes

THE term "plant mix" is used to describe a mixture of aggregates and bituminous material, made in a central plant, hauled to the road, spread and compacted. The mixes may be either hot laid or cold laid. Hot laid mixtures must be spread and compacted while hot, as workability is lost on cooling. Cold laid mixtures are spread and compacted at normal air temperatures, though they may be mixed hot.

Plant mixing permits a more exact control of the quality and grading of the aggregates, and, under proper specifications and inspection, assures a thorough and uniform mix. In addition, plant mixes can be placed under weather conditions that would not allow placement of other bituminous types, thus permitting work during a greater number of days each season.

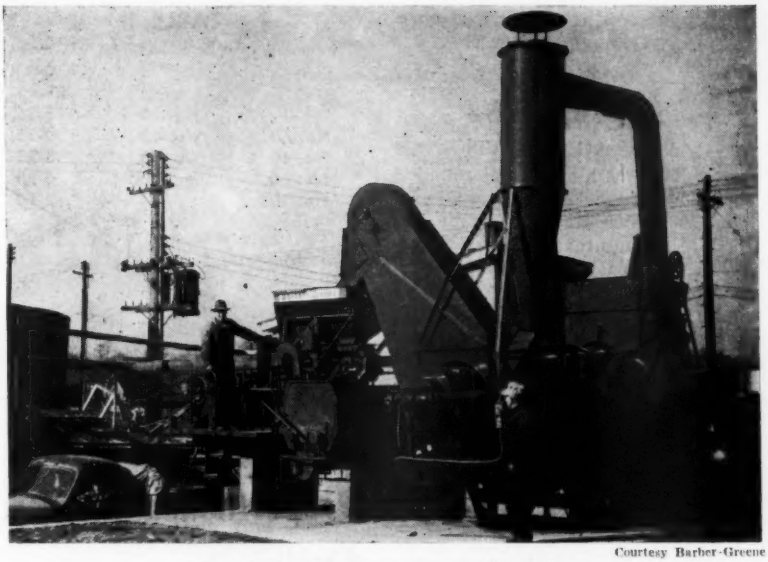
Since they differ in certain respects, hot mixes and cold mixes will be considered separately.

Hot Laid Mixes

MOST hot mixes are combinations of coarse aggregate, fine aggregate mineral filler and bituminous cement, the aggregates and filler being carefully graded to produce a dense mixture. Aggregates are passed through a mechanical dryer to reduce the moisture content to less than 0.5% and to raise the temperature to 250° to 340°F., so as to keep the material workable during the time required for mixing and finishing. A variation from the dense graded type employs an aggregate with relatively few fine particles and a viscous liquid bituminous binder. This type of pavement utilizes the interlocking of the aggregate particles and the coating of heavy bitumens for stability; and a seal coat is placed to waterproof and close the rather open surface. Sheet asphalt and "Topeka" or stone-filled sheet asphalt, are also hot mixes; but will not be discussed in this text.

The dense graded type of hot-mix

lay Equipment



Courtesy Barber-Greene

A hot mix plant set up on permanent foundations.

or bituminous concrete is adapted for heavy traffic streets, state and county highways, and airport runways. A seal coat is generally used on runways, and otherwise where the traffic density is light and not sufficient to keep the surface "alive" or "ironed out." The coarse aggregate type is suitable for light to medium heavy traffic. Its principal use is in areas where hard crushed stone or slag is readily available, but sand is scarce. Soft types of aggregate should not be used.

Hot-mix material may also be used for base courses, in which case coarser stone or a leaner bituminous content may be permissible.

Both asphalts and tars are used in hot-mix construction. In most cases, when asphalt cement is used, penetrations range between 50 and 100. In hot climates, penetrations are normally in the range of 60 to 80, to prevent softening after laying, even in very hot weather. In colder areas, softer asphalts are used, usually 80 to 100 penetration. On airport runways, the softer asphalt cements are used. On street work, Bangor, Me., has used 80 to 90 penetration; and Hartford, Conn., 85 to 100. Vermont on State highway work has used 85 to 100 asphalt cement, and Ohio the same, except on high-traffic-density pavements, where 70 to 80 penetration is used.

When tar is used, grades RT-11 or RT-12 are normally employed. When emulsified asphalt is used, a slow-setting grade as SS-1 is recommended.

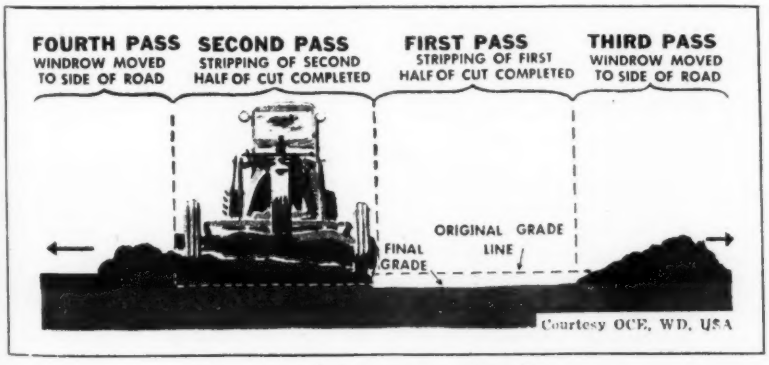
Bases for Hot Mixes

As with any other type of surfacing, a good base and/or subbase is necessary, the combined thickness depending upon the wheel loads and the type of underlying soil. The Asphalt Institute recommends, for good subgrades (A-1, A-2 and A-3 soils), a 6" wearing course; or a 3" wearing course and a 4" to 7" mechanically stabilized base, as macadam, slag or gravel; or 4" of asphalt macadam, road-mix or cold laid plant mix. For inferior subgrades, the Institute recommends a 6" surface layer of hot mix on an 8" subbase; or a 3" wearing surface on a 4" to 7" base course and an 8" subbase. These recommendations are essentially in line with those of the Public Roads Administration, and are suitable for relatively unfavorable conditions of traffic, climate and soils.

New Bases.—Many base types are available for use where all new construction is necessary. In general, the local material already at hand and in place will be cheapest if it can be utilized. Chemical or bituminous stabilization or soil-cement furnish adequate support for most roads. Texas has found lime valuable in making low-grade aggregates suitable for bases. On highways, wheel loads seldom exceed 10,000 pounds, and subgrade tests to determine bearing power are not generally necessary; but good drainage and good compaction are always essential.

Using Old Bases.—Existing street or road surfaces, if well drained, make very satisfactory bases for hot-mix surfaces. The years of traffic consolidate the surfaces and the soil under them. It is desirable to disturb as little as possible the surfaces and the underlying supporting material. Patching and leveling, widening, drainage and other improvement work may be needed, some of which is emphasized or described in other portions of this article, but the basic structure should be modified as little as possible.

Hartford, Conn., has found that 2 ins. of hot mix can be laid with satisfaction on old sheet asphalt, improving both profile and contour. It has been found particularly valuable on streets from which street car rails have been removed. In order to eliminate the transfer of existing cracks and breaks in the old pavement to the new one, the following procedure is used: Either the year before or early in the same season, 0.2 gal. of 120 to 150 penetration asphalt is applied at 375° F, or over, and covered at once with about 25 lbs. of sand premixed in a pug mill with about 2% by weight of MC-2 asphalt. The sand is applied at about 225°.



Using a motor grader to prepare the road base.

The street is opened to traffic at once. If fattiness develops, stone chips are applied.

Aggregates

COARSE AGGREGATES are defined as all material retained on the No. 10 sieve, and *fine aggregates* as all material passing the No. 10 sieve, though that passing the No. 200 sieve is classed as *mineral filler*. Usual specifications for the quality of the aggregate always apply; that is, the aggregate should be reasonably uniform in quality, have a suitable per cent of wear by the rattler test (usually not over 40), and be free from flat or elongated pieces. Uncrushed gravel must be angular in shape and have a rough surface texture. Slag should weigh at least 70 lbs. per cu. ft.

The limits of grading are reasonably flexible. Bangor, Me., found its crushing plant could not produce enough ½" stone, so used an aggregate composed of 30% of ¾", 27% of intermediate stone or buckwheat, 40% sand and 3% of fine material passing the 100 mesh. Hartford, Conn., in its resurfacing program, used a maximum sized aggregate of ⅜" stone and about 6% of 85-100 penetration asphalt cement. In Vermont, the surface mix used contained 15% of ½" to ⅜"; 20% of ⅜" to No. 4; 15% of No. 4 to No. 10; 21% of No. 10 to No. 40; 12% of No. 40 to No. 80; 5% of No. 80 to No. 200; 6% passing No. 200; and 6% asphalt.

While these aggregate gradings have been used successfully, the pavement should be designed carefully. Laboratory tests are necessary to insure a dense and stable surface. Consulting laboratories, state highway departments, and major asphalt and tar producers are available for advice and assistance.

The following specification for surface or intermediate courses is based on the Bureau of Standards Simplified Practice No. 57 (as modified by the Asphalt Institute):

TABLE I

Passing	Retained On	% Weight
1"	½"	17-52
½"	No. 4	6-42
No. 4	No. 10	5-15
No. 10	No. 40	4-20
No. 40	No. 80	8-25
No. 80	No. 200	4-16
No. 200	....	4-7

The total of No. 10 and coarser is required to be between 55% and 70%, and of the material passing No. 10, between 30% and 45%.

The following specification is from the Texas State Highway Department.

TABLE II

Passing	Retained On	% Weight
⅝"	½"	0-3
½"	¼"	25-45
¼"	No. 10	15-35
No. 10	No. 40	0-25
No. 40	No. 80	5-25
No. 80	No. 200	5-25
No. 200	....	2-10

The material coarser than No. 10 must comprise 50 to 65% of the total.

When tar is used, the aggregates are often limited to ½", and the same is true with emulsified asphalt. On binder or base courses, larger stone, up to 1½" or even 2" are used. With asphalt, 5% to 7% of bitumen is generally used; with tar, a somewhat higher per cent.

Proportioning the Mix

DESIGNING and proportioning the bituminous concrete mixture involves calculations of the various aggregate fractions. In some cases, a single aggregate will meet all requirements; in others, two or more aggregates will have to be blended in order to obtain the gradations desired. For instance, assume the requirements of Table I, and the following coarse aggregate which must be combined with fine aggregates to meet the specifications:

TABLE III

Passing	Retained On	% Weight
1"	½"	50
½"	No. 4	38
No. 4	No. 10	10
No. 200	....	2

The approximate mid-point of the 55% to 70% coarse material required by Table I is 62%, and the mid-point of the 4% to 7% mineral filler is 5%; this totals 67% and leaves 33% of fine aggregate. Of the total mix, the 1"-½" material will amount to 50% x 62%, or 31%; the ½" to No. 4 will comprise 38% x 62% or 23.6% of the total; and the No. 4 to No. 10 will be 6.2%. Fine aggregate and filler will be computed in a similar manner on the basis of 5% and 33%. If the final mix is not within specification limits, percentage adjustments must be made or other aggregate fractions added.

Example 1.—Assume the specification shown in Table II, and combine the aggregates shown in Table IV to meet this specification:

It will be noted that No. 1 is a coarse aggregate, No. 2 is largely screenings, and No. 3 is sand.

The proportions in which these aggregates are available may have some influence on the proportioning. To simplify the example, it will be assumed that the quantities are unlimited. Furthermore, in selecting the sizes to be used in working out this explanatory procedure favorable aggregate compositions have been employed. A good discussion of this subject appears in "Hot Mix Asphaltic Concrete Paving," available from the Asphalt Institute on request.

The specifications given above require that 50% to 65% of the material must be retained on the No. 10 sieve. This material must come almost entirely from Aggregate No. 1. The mid-point of 50% to 65% is about 57%, and a trial may be made by using 57% of Aggregate No. 1. To provide the needed fine material a trial may be made by using 8% of Aggregate No. 3, so as to give about 4% in each of the categories 40-80 and 80-200.

If 57% is taken from Aggregate No. 1 and 8% from No. 3, the remainder or 35% will come from No.

TABLE IV

Passing	Retained On	Aggregate No. 1	Aggregate No. 2	Aggregate No. 3
⅝"	½"	1.0%	...	...
½"	¼"	56.0	...	...
¼"	No. 10	41.0	1.8%	...
No. 10	No. 40	1.0	54.7	0.5%
No. 40	No. 80	0.5	17.5	50.2
No. 80	No. 200	0.5	12.0	45.8
No. 200	...	0.0	14.0	3.5

TABLE V

Size	No. 1	No. 2	No. 3	Combined
⅝—½	0.6%	—	—	0.6%
½—¼	31.9	—	—	31.9%
¼—10	23.4	0.6%	—	24.0
10—40	0.6	19.2	—	19.8
40—80	0.2	6.1	4.1%	10.4
80—200	0.3	4.2	3.7	8.2
Passing 200	—	4.9	0.2	5.1
	57.0%	35.0%	8.0%	100.0%

2. The gradings shown in Table IV are therefore multiplied by these percentages, that is, No. 1 gradings by 57%; No. 2 gradings by 35% and No. 3 gradings by 8%. The results will be as shown in Table V.

It will be noted that the combined aggregate meets the requirements of the specifications reasonably well. It will therefore be used. Specific gravity is necessary for certain of the tests, as indicated later, and is assumed here at 2.577.

The next step is the determination of the proper proportion of the asphalt cement. In order to determine the best mix, samples with varying contents of asphalt are made up and tested for specific gravity, density and stability. With specifications calling for an asphalt content of 5% to 7%, tests are usually made with 5%, 5½%, 6%, 6½% and 7% asphalt. The aggregates used are, for 5% of asphalt, 95% of the quantities shown in the combined column of Table V; for 5½%, 94½% of the aggregate quantities, etc.

This test is a laboratory test, covering density, which is computed from the theoretical and actual specific gravities, and the stability. Assume the results are as plotted on Figure 1, page 32. Assuming a density of 96% is desired, the intersection of the lines indicate that 6.1% of asphalt is required. By prolonging this line to the stability curve, and thence upward, the stability is shown to be about 48.5% which is satisfactory. This mix will therefore be used. The mix will therefore consist of 6.1% of asphalt cement and 93.9% of each of the gradations shown in the last or Combination column of Table V. [This example is based on the practice of the Texas State Highway Department, which uses a stability per cent. Normally, for heavy traffic conditions, the stability at 140°F. for surface course mixtures, expressed in pounds, will range between 2,500 and 6,000.]

The aggregates Nos. 1, 2 and 3

Photo by Huber

Shoulders should be kept level.

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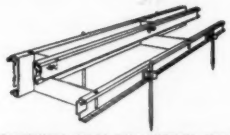

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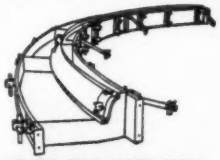

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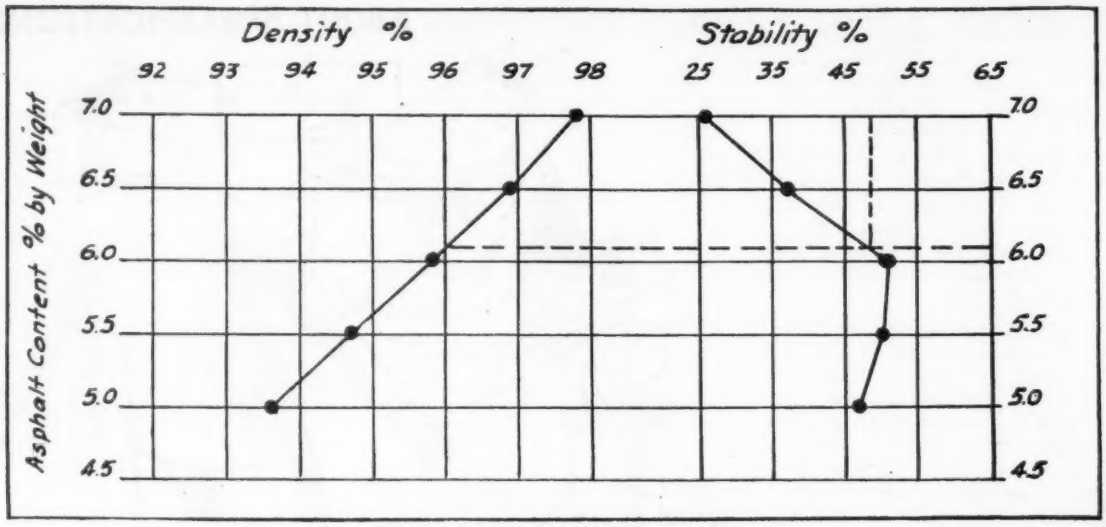

Fig. 1. Density, stability and asphaltic content relationships.

are fed into the dried in the proportion of 57%, 35% and 8%. After drying, the aggregate is screened into 3 sizes and stored in 3 bins (there may be more or less bins, however). It is now necessary to determine how much must be drawn from each bin for the mix. The first step is to make a screen test of the aggregates in each bin. Assume the results are:

TABLE VI

Size	Bin A	Bin B	Bin C
⅜—½	—	—	3.1%
½—¼	—	33.5%	96.9%
¼—10	—	61.7	—
10—40	45.5%	2.2	—
40—80	23.9%	1.1	—
80—200	18.9%	0.9	—
Passing 200	11.7%	0.6	—
	100.0%	100.0%	100.0%

As stated above, aggregates amount to 93.9% and asphalt cement to 6.1% of the total mixture; therefore the numbers in the final or combination column of Table V must be multiplied by 93.9% to determine the percentage of each in the final mixture. In starting the necessary computations it is easier to take a size that is contained wholly in one bin, and a comparatively large sam-

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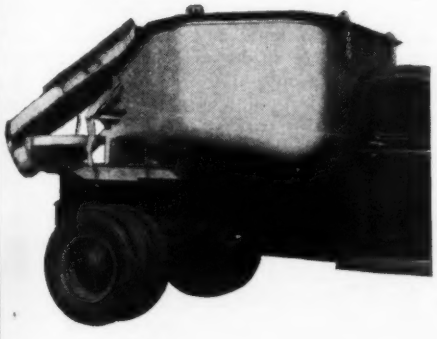

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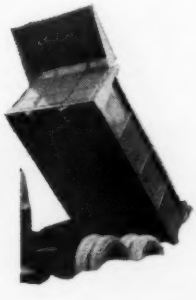

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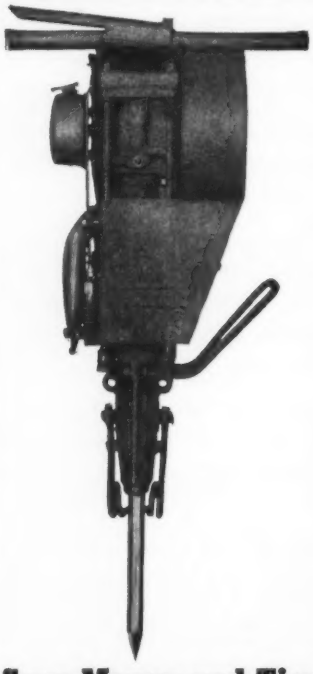
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ple. It is evident by inspection of Table VI that all of the ¼" to 10 mesh will come from Bin B. The amount required is determined by multiplying 24% (last column of Table V) by 93.9% (the aggregate proportion) which gives 22.5% which is the proportion of ¼" to No. 10 material required. Of the material in Bin B, 61.7% is ¼" to 10 mesh; therefore, Bin B will contribute 22.5% ÷ 61.7% or 36.5% of the total. Table V indicates that ½" to ¼" must compose 31.9% x 93.9% or 30% of the mix. Bin B will furnish 33.5% x 36.5% or 12.2%. The other 17.8% must come from Bin C, 96.9% which is of this size. Therefore Bin C will contribute 17.8% ÷ 96.9% or 18.4% of the total.

The proportion furnished by Bin A will be 93.9%—(36.5% + 18.4%) or 39%. There will be 6.1% of asphalt cement. For a 2000-pound batch, the weights would be:

Bin A, 39.0 x 2000	780 lbs.
Bin B, 36.5 x 2000	730 lbs.
Bin C, 18.4 x 2000	368 lbs.
Asphalt cement, 6.1 x 2000	122 lbs.
	2000 lbs.

The various fractions shown in Table VI may be multiplied by the appropriate percentages indicated above and checked against the Combination column of Table V. This will not agree precisely, but will usually be within specification limits; if not the mix must be recomputed, using some other fraction of the aggregate as a primary base. In this case, either Bin A or Bin C would furnish a satisfactory starting point.

Somewhat similar methods of designing mixtures are given in the Hot-Mix Asphaltic Concrete Manual of the Asphalt Institute and in Principles of Highway Construction, issued by the Public Roads Administration.

Mixing and Mixing Equipment

MIXERS are of two general types, the batch and the continuous. The batch mixers are charged with a specific amount of material which they mix and then discharge. These mixers may be either rotary drum or twin pug mill. The continuous mixers are fed continuously with aggregate and bitumen in the desired proportions, the components entering at one end of the mixing chamber and being discharged at the other end.

No matter what the type, a standard hot-mix paving plant must consist of a drier, a screening or grading unit, a batching or proportioning system and a mixer. Other units may be added, including hot and cold aggregate elevators, crushers, screening units, storage tanks or bins for bitumen and aggregates, temperature controls, and locking and timing equipment. Capacities over a wide range are available.

Hauling.—The hot mixture should be transported in tight vehicles with clean metal bottoms. When it is necessary to do so in order to maintain a proper laying temperature, the loads should be covered with canvas and delays reduced or eliminated. Light applications of thin oil or of a soap solution may be made to assure clean dumping.

Placement.—The base on which the hot mix is to be placed should be (1) reasonably dry and certainly free from standing water; and (2) cleaned of all loose and foreign material so as to insure a good bond and contact. Detail preparation of the base should

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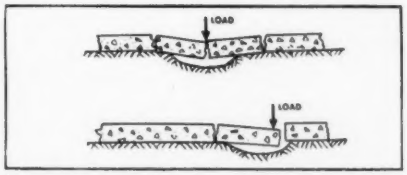

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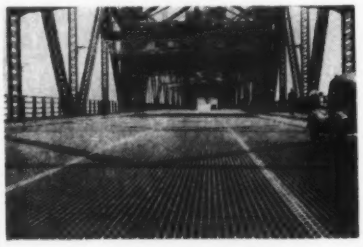

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Pavers have hoppers into which the truck dumps its load. Distributing screws spread the paving mixture evenly in front of the screeds. Operating speeds vary between 10 ft. and 20 ft. per minute. When pavers are not used for spreading, the mixture should be dumped on steel sheets outside of the area on which it is to be spread, and then distributed by hot shovels and rakes to a uniform depth.

Joints

Well bonded and sealed joints are necessary. When using a paver, the consolidating action of the tamper permits satisfactory joints to be made between the new hot material and previously laid pavement. The Public Roads Administration does not permit the roller to pass over an unprotected end of freshly laid mixture unless laying is to be discontinued long enough for the pavement to chill. Under such conditions, when laying is renewed the cold pavement is cut back to expose its full depth, the edge painted with hot asphalt cement, and the new hot mixture placed against this edge and compacted.

Contact surfaces, as curbs, gutters, and manholes, should be similarly painted and hot smoothers or tampers used to insure compaction and a good bond.

When the pavement consists of two or more courses, as base or binder and surface courses, the joints in the surface course, both longitudinal and transverse, should be offset at least 6 ins. from those in the binder courses.

Compaction

Three-wheel or tandem rollers are normally used for compacting the surface. Weight should be not less than 10 tons. Rolling should start as soon after spreading as possible without undue displacement of the pavement. Rolling begins at the sides and proceeds toward the center, the rear wheels overlapping by one-half their width on successive trips. Where the surface is wide enough, tandem rollers should be used for diagonal rolling. Roller speed should not exceed 3 miles per hour and only rollers in good condition should be used. During rolling, the surface is checked with a straightedge to determine its uniformity of cross-section and grade.

Inspection and Control

Inspection of bituminous construction projects of all kinds should cover (1) materials; (2) preparation of the mix; and (3) placement of the mix. ASTM D-290 covers recommended practice for bituminous pav-

Rolling a joint on a plant mix job.

ing plant inspection in some detail. A brief outline of important points to be observed will be given here.

Inspections at the Plant.—All measuring and timing devices and temperature indicators should be checked for accuracy. Screens should be examined to insure they are the proper size and so placed that overflow cannot occur from one bin to another. Aggregate discharge gates and asphalt control valves should be checked. The mixer should be examined to see that the discharge gate prevents leakage and that the blades are not unduly worn and are set for proper mixing. These factors having been determined satisfactorily, the inspector's duties are primarily to insure uniform and satisfactory output. Duties will include checking the proper proportioning of the mix, recording the time of mixing, the batches and loads of mixture produced and the amounts of the various materials used. The inspector should make proper tests, or take necessary samples and arrange to have the tests made. These should include sieve analyses of heated aggregate and mineral filler, penetration tests on the asphalt used, and extraction and sieve analyses of aggregate recovered from composite samples of the finished mix.

Photo by Seaman

Using a pulvimixer on shoulder reconstruction.

Inspection on the Job.—A first duty is to see that the base or subbase has been satisfactorily prepared for the pavement. In addition to measurement of the grade and cross-section, this will include examination to determine freedom from moisture, tightness of bond and cleanliness. Equipment to be used on the work, especially spreaders and rollers should be examined for compliance with specifications covering type, condition and weight. Each load of mixture arriving on the job should be recorded and examined for indications of poor mixing, segregation, excessive bitumen content or overheating. The completed surface should be checked for thickness and core samples taken at intervals.

Since compaction of the mixture is generally specified in terms of equipment required and amount and type of rolling to be done, this should be checked carefully. Development of surface defects while rolling should be noted and the causes determined so that corrections can be made. Grade and cross-section of the finished surface should be checked.

Cold Laid Mixes

THESE surfaces consist of a mixture of mineral aggregates and bitumen, both of which are heated prior to mixing. In general, these mixes differ from the hot laid mixes in that a lighter or less viscous grade of bitumen is used, and aggregates are not so rigidly graded. Aggregates should be dried to a moisture content of 1% to 1½%. Local ag-

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Harber-Greene Photo

A travel-plant working on sand-asphalt.

gregates are often used without special preparation on blending except where there are marked deficiencies in certain fractions. A lower percentage of bitumen is normal than with hot mixes. Depending on the type of aggregate used, stability may depend to a considerable extent on the interlocking of the aggregate particles. A seal coat is placed to compensate for the lean mix.

Such surfaces are sometimes referred to as oil mats or retreads. Actually, they may vary from a close approximation to hot mixes when an asphalt cement is used and the aggregate approaches the theoretical gradation, to a similarly close approximation to a road mix (see page 42).

Cold laid mixes, depending upon their characteristics, are suitable for a variety of applications, ranging from light to moderately heavy traffic.

Both tar and asphalt are used in cold lay mixes. The tars used are generally RT-8 or RT-9, though RT-7 is employed for some types of mix, and RT-10 when the weather is warm. The asphalts used are the cutbacks, generally the RC or MC grades. Some use has been made of asphaltic cements, and also of a combination of powdered asphalt and SC cutbacks. Results with these are very promising. Usually 4% to 6% of bitumen is used.

Softer grades of bitumen may be used on airports, playgrounds and other surfaces where traffic density is light.

Types of Cold Laid Surfaces

The Asphalt Institute has issued specifications for two types of cold lay mixes, the macadam aggregate type, and the dense graded aggregate type. The former is stated to be merely a refinement of the macadam aggregate type of road-mix construction. It utilizes the same type of aggregate and is finished with a seal coat. However, a more viscous binder is used than in road mix, and the bitumen percentage is smaller than in hot mix—usually 3½% to 5% of asphalt.

The dense graded aggregate type is likewise an adaptation of the dense graded-mix-in-place construction (which is described later in this article), somewhat more attention being given to aggregate gradation. Usually 4% to 6% of binder is used, and the surface must be sealed.

Specifications have also been prepared for two types of cold laid surfaces using tar. A more rigid gradation of aggregate sizes is required, which is nearly the same as that used in the hot mixes. One of these is cold lay tar concrete; the other is dense graded tar plant mix, which is comparable to the road mix. The tar

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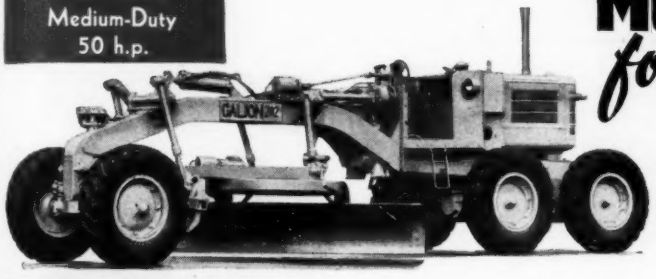

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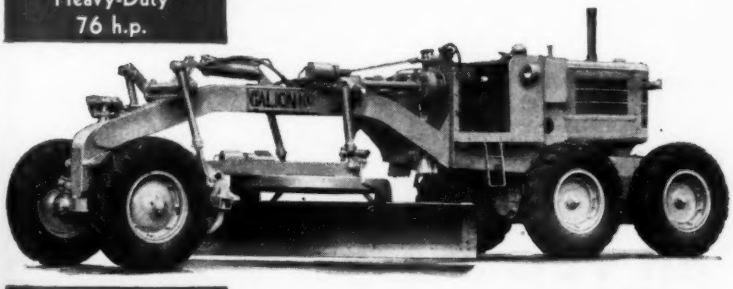

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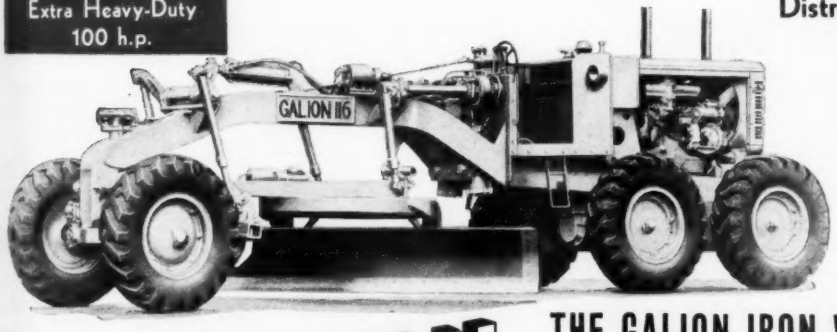

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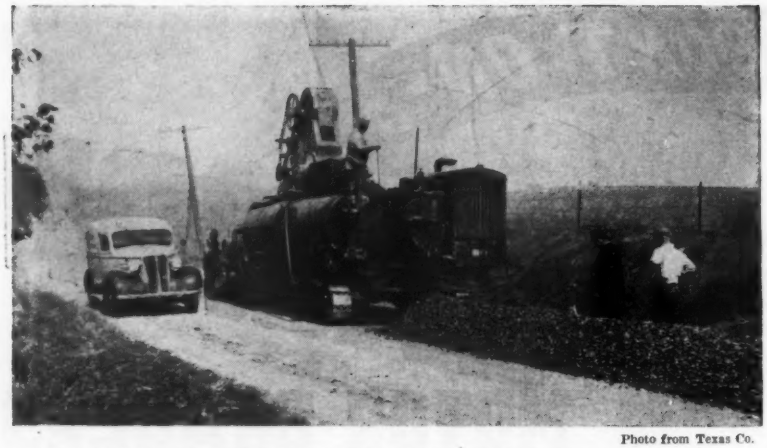


Photo from Texas Co.

Oil and local aggregate being mixed and deposited in windrow by travel-plant.

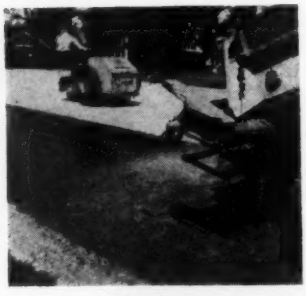
concrete is more closely controlled as regards aggregate sizes. Both use from 6% to 8½% of binder. With certain aggregate gradations, a tar seal coat is required.

There are also a number of proprietary pavements of this type which can be purchased ready for laying. These include: Tarvia-Lithic which is furnished by the Barrett Co. in two grades, coarse and fine; Bituvia, furnished by Reilly Tar and Chemical Corp.; Colprovia, which is used in preparing either hot or cold mixes; Kotal; and Laykold asphaltic concrete of the American Bitumuls Co.

Bases for cold laid mixes should be well-drained, firm and prepared as described elsewhere in this article (see page 48). With the asphaltic mixes, the base or subgrade is primed with 0.3 to 0.8 gal. per sq. yd. of MC-O, using a pressure distributor and oil at a temperature between 50° and 150°. When tar mixes are used, priming is usually omitted.

Seal Coats.—When using tar, the seal coat consists of 0.15 to 0.30 gal. per sq. yd. of tar heated to the range 150°-225°, applied with a pressure distributor, and covered with 6 to 12 pounds of fine aggregate per sq. yd. This is applied after the pavement has been consolidated by traffic for 30 to 60 days.

When using asphalt, seal coats are used unless the top surface layer is a dense mix. They are applied not less than a week after completion of the wearing course. Usually 0.2 to 0.3 gal. per. sq. yd. of an RC asphalt is applied by distributor and covered with 10 to 20 pounds per sq. yd. of fine aggregate.



Applying chips for seal coat.

Seal coats are used for all of these types when laid on airport runways, playgrounds, and similar places where traffic is light or infrequent.

Aggregates

Since a considerable latitude in aggregate gradations is permissible, requirements or specifications shown herewith should be considered illustrative and not entirely restrictive.

The following gradations for macadam aggregate type, cold laid as-

Photo by Barber-Greene

Loading paving aggregate.

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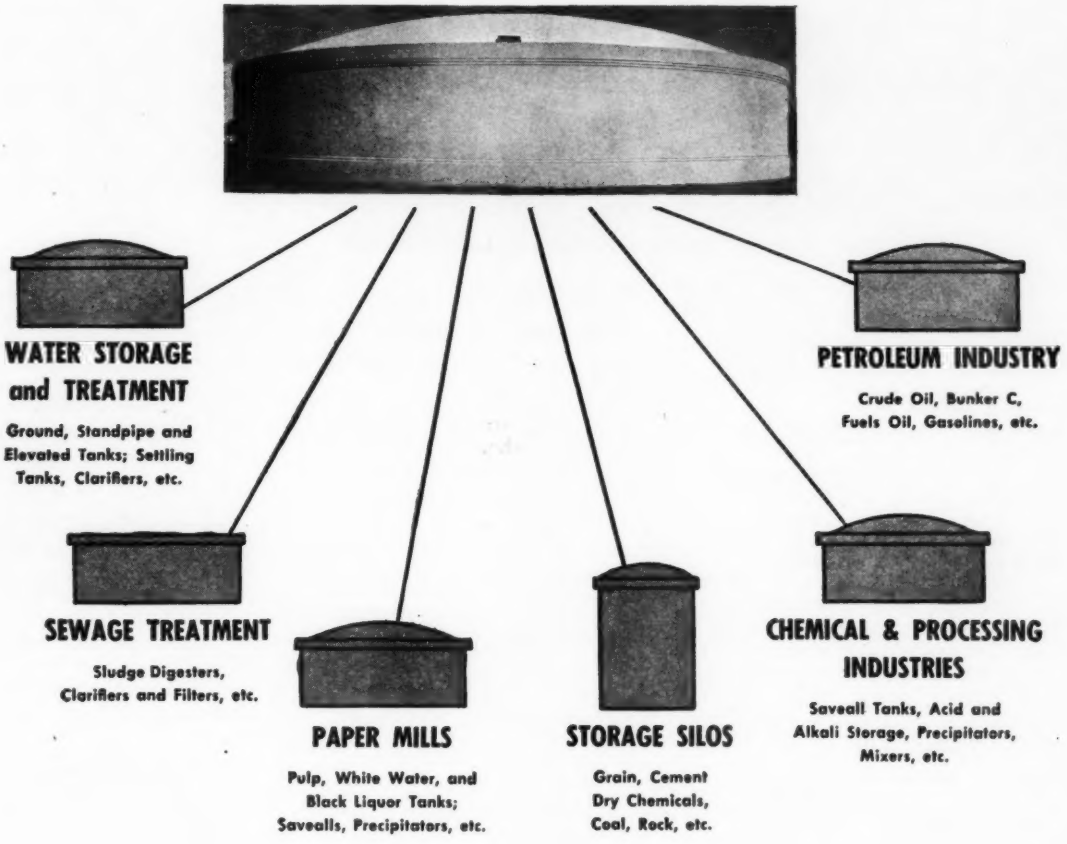

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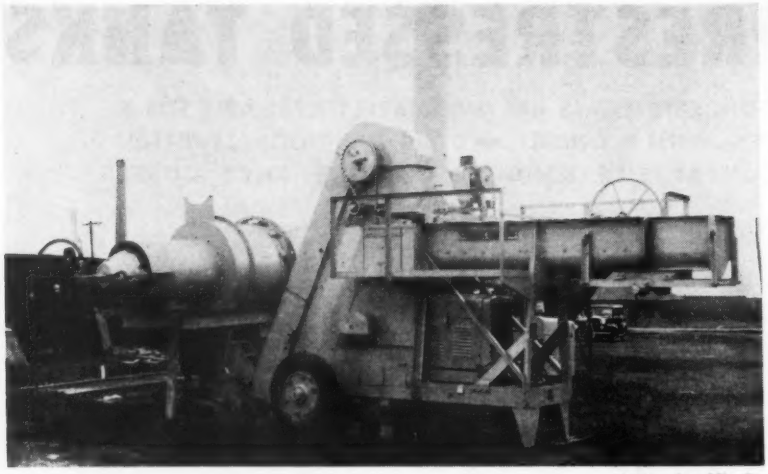


Courtesy Iowa Mfg. Co.

An asphalt mixing plant for small jobs and patching.

phaltic plant mix are from the Asphalt Institute:

TABLE VII

Total Passing	Per Cent
1½" sieve	100
1" sieve	90-100
¾" sieve	40-75
½" sieve	15-35
⅜" sieve	0-15
No. 4 sieve	0-5

The following specifications for surface course aggregate for the dense graded aggregate type of cold laid asphaltic plant mix are also from the Asphalt Institute:

TABLE VIII

Passing	Retained On	Per Cent
1"	½"	15-25
½"	No. 4	20-35
No. 4	No. 10	5-25
No. 10	No. 200	25-35
No. 200	—	4-6

The Public Roads Administration uses the following aggregate for its Class F, type F-2, open graded plant mix surface course:

TABLE IX

Passing	Per Cent
1" sieve	100
¾" sieve	90-100
⅜" sieve	20-55
No. 4 sieve	0-10
No. 8 sieve	0-5
No. 200 sieve	0-2

The following specifications are for cold lay tar concrete, top course:

TABLE X

Passing	Per Cent
½" sieve	100
⅜" sieve	80-100
No. 4 sieve	40-75
No. 10 sieve	25-55
No. 40 sieve	10-30
No. 200 sieve	0-8

Construction Procedure

The procedure in constructing the pavement is essentially the same as that outlined for hot laid mixes, and the equipment used is generally the same. However, on the dense graded aggregate type, Asphalt Institute specifications permit windrowing of the mix and spreading by either a mechanical spreader or by blade graders; and for this type of surface a 5 to 8-ton roller is used. When the more viscous bitumens are used, mechanical spreaders are desirable and often required by the specifications.

Inspection.—The duties of an inspector on cold-lay plant mix construction are essentially the same as those outlined for hot-mix hot lay surfaces; often, however, they will be less exacting due to the less rigid gradation requirements of the aggregates. Control of temperature may be important, in that aggregate requires heating only for drying, and a temperature that is too high may modify the characteristics of the bitumen by driving off the more volatile constitutents.

Mixed-in-Place Construction

THIS is a term used to describe the mechanical mixing of aggregate and bitumen directly on the road. Other names for the process are retread, oil-mix, and turn-over. This method is used advantageously where all or part of the aggregate to be used is already available on the road, enough either for the base or for the entire pavement.

There are three general types of mixed in place surfaces, classification being on the basis of type of aggregate. These are (1) the coarse or macadam aggregate type; (2) the dense graded aggregate type; and (3) the sand (or soil) aggregate type. Likewise there are two general methods of construction (a) mixing by blade graders, drags or other similar devices; and (b) by using traveling mixing plants.

Unless new surface is to be placed on an existing bituminous surface, and sometimes even then, a priming coat is applied. A seal coat is placed on the finished surface.

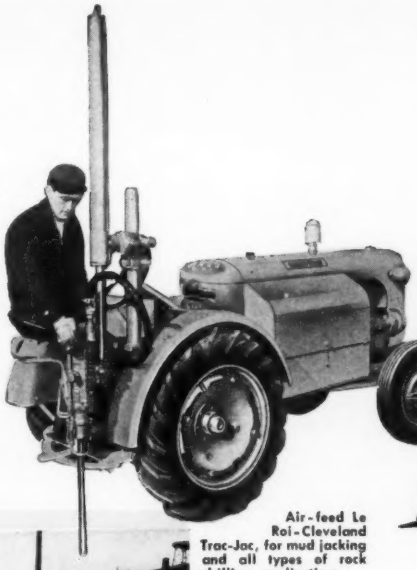
The construction procedure may be summarized as follows: (1) Priming the base; (2) mixing and compacting the pavement; (3) placing a seal coat.

Bitumens Used

For the open, coarse, or macadam aggregate type of road mix, RC 2, 3 or 4, or MC 2, 3, 4 or 5 cutback asphalts are used; RT 6, 7, 8 or 9 tars; and a quick-setting grade of emulsified asphalt. For the denser graded types of mixes, MC 2, 3 or 4 is the

Photo by Texas Co.

Working a road-mix with a motor grader.



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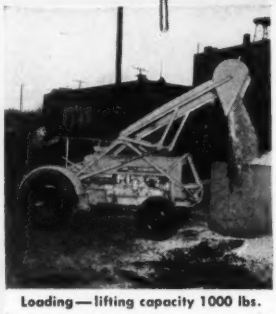

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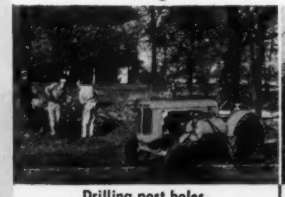

Drilling post holes.

Backfilling.

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Tulsa winch driven by power take-off.

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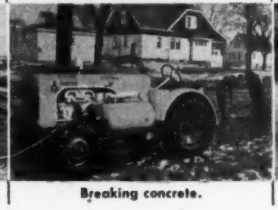

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Courtesy Gallion

Tandem roller compacting a new surface.

asphalt principally used, though the Asphalt Institute recommends RC 2 or 3 where there is little or no material passing the 200 mesh. When tar is used, RT 5 or 6 is recommended for early spring and late fall and RT 6, 7 or 8 for summer construction. The quick-setting grade of emulsion is recommended for fine aggregate mixes by American Bitumuls.

Aggregates

There is so much latitude in aggregate gradings suitable for road mixes that specifications are largely meaningless. However, for the coarse or macadam aggregate type, typical specifications for aggregates are shown herewith:

TABLE XI

Total Passing	*Coarse Mix*	*Fine Mix*	
1½" sieve	100%	—	—
1" sieve	90-100	—	—
¾" sieve	40-75	100%	—
½" sieve	15-35	90-100	100%
⅜" sieve	0-15	40-70	85-100
No. 4 sieve	0-5	0-15	10-30
No. 8 sieve	—	0-5	0-10

For the dense graded type, the aggregate may include broken stone, gravel, sand, stone screenings and mineral dust. Specifications for aggregate are illustrated by the following from the asphalt and tar producers:

TABLE XII

Total Passing	*Asphalt*	*Tar*
1" sieve	100%	100%
No. 4 sieve	50-70	40-75
No. 10 sieve	35-60	—
No. 200 sieve	5-14	0-10

Public Roads Administration specifications for aggregate for this type cover 5 gradings, all having 100% passing 1"; and with varying proportions of the finer materials.

While grading of aggregate need not conform to narrow specifications, it should be as uniform as possible for the entire length of any specific job.

Construction Procedure

When a mix-in-place surface is to be placed on an existing road, depressions in the base should be patched and the road brought to a proper crown and grade. It is then primed (sometimes priming is omitted when the old surface is bituminous), after which the aggregate is placed, the binder applied and mixing begun. When existing material is to be used, the road surface is scarified to the required depth and the scarified material is then reduced to a uniform condition by disks, harrows or blades and bladed to one side. After priming, if new material is to be added, this is either placed in windrows for travel plant operation, or spread on the road for drag or blade mixing. Binder is added, after which mixing proceeds. This is followed by rolling and later by the application of a seal coat.

Travel plants may proportion and mix the bitumen and aggregate in a single continuous operation. In such cases, the aggregate, either existing material, new material or both, is windrowed instead of being spread out. The travel plant picks up the windrowed material, adds bitumen, mixes and deposits the mixed material either in a windrow or into a paver. Travel plants are advantageous in permitting an accurate control of bitumen, in allowing the use of heavier grades of bitumen and in reducing time lost due to bad weather.

When travel plants are not used, the aggregate is spread out level, and bituminous materials are applied in one or more increments by pressure distributors. After each application of the binder, the aggregate and binder are mixed by repeated turnings with blade graders, harrows or mixing machines. After this is completed, the mixture is spread and compacted.

In addition to the travel plants, which are mixers of the pug-mill type, there are mixers of multiple-blade type which are hauled by a tractor. These units mix the binder and aggregate and leave a surface

Turn to pages 48 and 49 for the remainder of the article.

Photo by Barber-Greene

A travel-plant windrowng mixed material ready for spreading.

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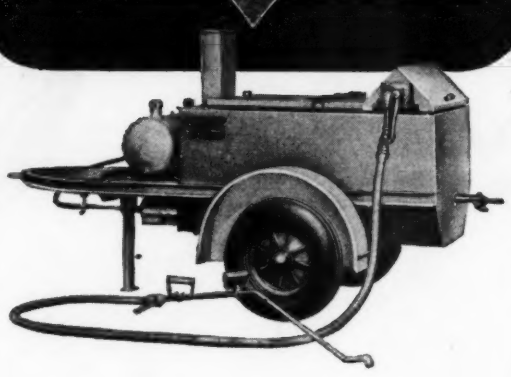

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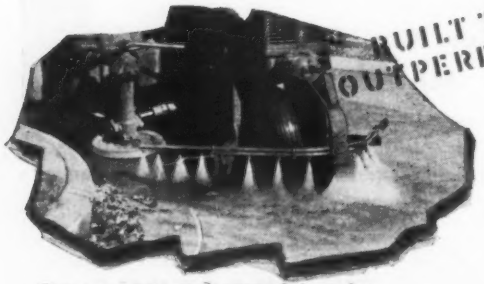
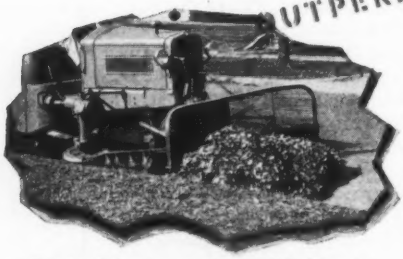
Performance Pr



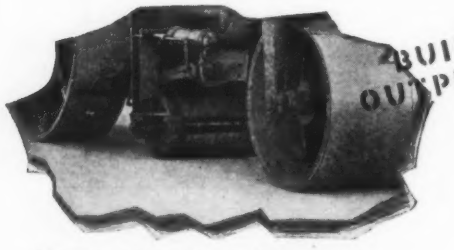
Cleaner streets, and more of them, for less money ... thanks to the many exclusive features of the Model 40 Sweeper.

3 NEW Power Graders

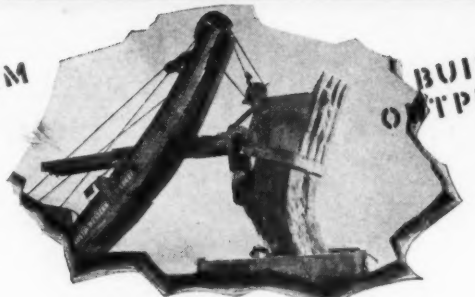
See them at the Road Show!



The Leaf Broom on the Model 40 collects the leaves in handy piles for loading into trucks.



Smoother riding, longer lasting pavement ... thanks to the automatic, straight-edge action of the 3-axle Roll-A-Plane.



Badger ¾-swing design means more swings per minute, more yardage per hour, more profit for the owner.

AUSTIN-WESTERN COMPANY, AURORA, ILLINOIS, U. S. A.

BUILDERS OF ROAD MACHINERY

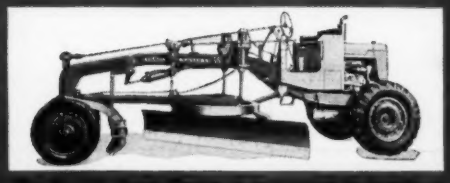
Austin Western

SINCE 1859

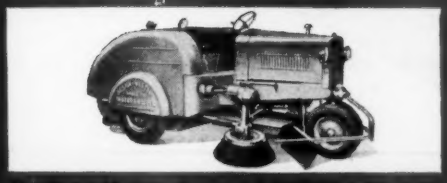
ePreview

***Performance* — not machinery — is what you buy, and performance is what we sell. Exclusive "Built to Outperform" features are found in every Austin-Western machine . . . Plus Values accumulated by engineering experience that has lived close to road building and earth moving problems and practices since the first crude Austin-Western tools of 1859.**

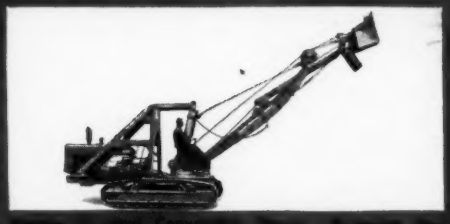
Let's talk performance!



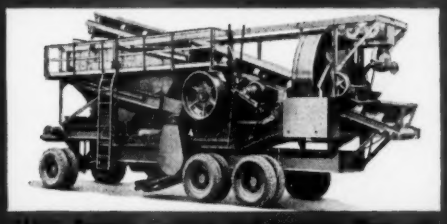
wide variety of maintenance and light grading jobs



hand or left-hand gutter broom or both. Famous for

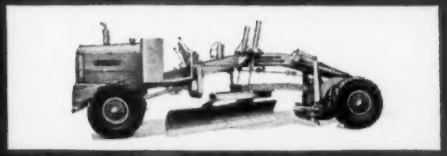


sign eliminates tail swing; increases stability, visi-



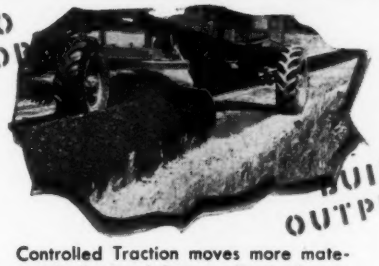
jaw and roll crushers. One of many standard and

sizes. Variable Weight Tandem Rollers are made in



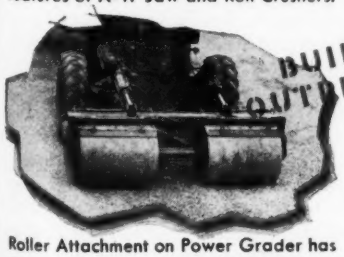
cluding All-Wheel Drive, All-Wheel Steer, High-Lift

Austin-Western Crushing Plants are tops in output, thanks to the exclusive design features of A-W Jaw and Roll Crushers.



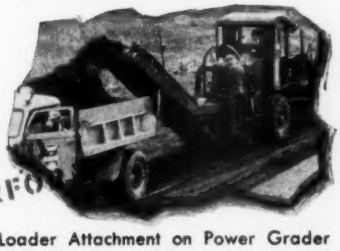
Controlled Traction moves more material farther and faster; all wheels miss the windrow.

The 13-foot blade reaches several feet higher . . . thanks to the climbing power of All-Wheel Drive.

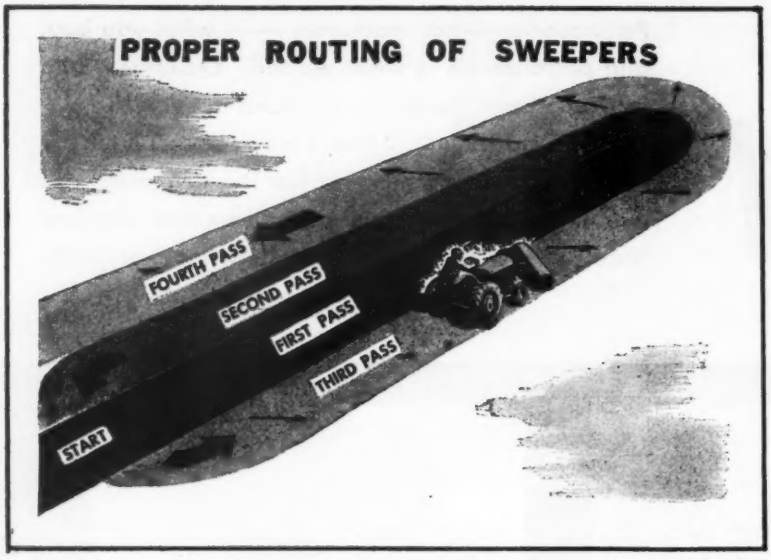


Roller Attachment on Power Grader has many uses . . . saves investment in costly, single-purpose equipment.

Rear steer makes it possible to finish slopes and shoulders in 10-foot swaths, leaving no tire marks.



Loader Attachment on Power Grader trims shoulders, balances quantities and does much other shallow excavation.



Courtesy OCE, WD, USA

How to use a power sweeper effectively.

Low-Cost Roads

(Continued from page 44)

spread to the desired width and section.

Coarse or Macadam Aggregate

Unless a travel plant is used for mixing, the binder is applied, when using asphalt, in two equal applications, the first being mixed thoroughly before the second is applied. For a 2-in. thick surface, 0.6 to 0.8 gal. per sq. yd. is used. After mixing, a power roller weighing not less than 10 tons is used for compaction, but the mixture should be tacky before rolling begins. The surface is finished by spreading fine aggregate over the surface to fill the surface voids, and then applying 0.2 to 0.3 gal. per sq. yd. of asphalt binder. This is followed by more rolling and the application of fine aggregate, with brooming.

When tar is used, 0.8 to 0.9 gal. per sq. yd. is applied, followed immediately by mixing, spreading and leveling, and initial rolling with a 10-ton roller. Fine aggregate is spread to fill the voids, and this is followed by rolling and a second application of tar, 0.3 to 0.4 gal. The final application of fine aggregate is then made.

Dense Graded Aggregate

When a travel plant is used, sufficient asphaltic binder is added so that the final mixture contains 4% to 7% of asphalt. When mixing is by blading and dragging, asphalt is applied in increments of 0.5 gal. per sq. yd. until the final mixture contains 4% to 7% of asphalt, mixing being continued between each application of binder. Pneumatic or steel wheeled rollers are used for compaction.

When tar is used, the normal application for a 2" deep surface is 0.8 to 1.0 gal. per sq. yd. This is applied in two or more increments, each being followed by mixing. An 8-ton or heavier roller is used for compaction, which is followed by application of the seal coat and final rolling.

The same general procedure is used with emulsions. American Bitumuls Co. recommends the use of quick-setting emulsified asphalt on the basis of quantity determined by the following formula.

$$P = .05\ A + 0.1\ B + 0.5\ C$$

where P is percentage by weight of Bitumuls used;

A is percentage of the aggregate retained on the 10 mesh;

B is percentage between 10 and 200 mesh;

C is percentage passing 200 mesh.

Sand Mixes

In areas where much sand occurs locally, it may be used with bitumen binder to form a very satisfactory surface. If available, a mineral filler, its composition depending on the characteristics of the sand, may be added to increase density and stability. The binder used may be tar, RT 3 or RTC or asphalt RC 2 or 3 or MC 2 or 3, composing 5% to 10% of the mix. The soil is plowed or scarified somewhat deeper than the proposed depth of the pavement. The bituminous binder is applied in increments when road mix methods are used, and followed by mixing with graders, scarifiers, harrows and other equipment. Initial compaction is with a pneumatic tire roller, and this is followed by a tandem roller. A seal coat is required.

Surface Treatment

"Surface treatment" is the term generally employed to describe the application of bituminous materials and aggregate to a roadway for the purpose of hardening, smoothing or water-proofing its surface. It is known also by such terms as road oiling, surface mat, armor coat and carpet coat. A considerable variety of materials and of construction procedures are available for applying this treatment.

Since surface treatments do not add materially to the strength of a road, but only provide a smooth, dustless, all-weather surface, the traffic load they can carry is restricted to that of the original roadway. In general, they are suited, when placed on well-drained and compacted surfaces, to a moderate volume of light or medium traffic, but not to heavy truck traffic.

Two or more treatments are sometimes applied to give greater thickness; however, the term "surface treatment" is usually restricted to surfaces not greater than 1" in thickness.

General procedure in surface treatment construction is as follows: The surface to be treated is primed with a low viscosity bitumen; and after this has penetrated and dried, an application of heavier bitumen is made and covered immediately with stone chips. This may complete the treatment, or second applications of both bitumen and aggregate may be made. As a final step a seal coat may be applied.

Preparation for Surface Treatment.—Plant mix and road mix surfaces already described are applied in such a thickness that even considerable inequalities in the base can be eliminated. The thin surface treatment layer can not correct any but very minor irregularities in the surface to be treated and does not lend material strength to the road. Therefore, particular attention should be given to preparing the road for surface treatment. A smooth contour and uniformity of surface should be provided. In mosts cases, it is not desirable to scarify the road to remove deep holes or major irregularities. It is better to retain the surface and base, normally well compacted by traffic, and patch the surface before the treatment is applied. So nearly as possible, patch material should be similar to the original sur-

face. Otherwise, a cold patch mixture is used. The differential wear, resiliency or compaction of adjacent small areas are important factors in causing break-ups, pot holes and localized failures, therefore care should be taken to provide, so far as possible, a uniform surface on which to place the new covering.

Good drainage is an essential. Surface treatment does not add materially to the strength of the road; it provides a waterproof wearing surface; and it may attract additional traffic to the road over and above what it previously carried. Subsurface and surface drainage must be adequate to permit fullest utilization of the load-carrying ability of the original roadway.

Bitumens and Aggregates

Both asphalts and tars are used for binders in surface treatments. Of the former, the rapid curing asphalts, RC 1 to 5 are used; also MC 2 and for heavy treatments MC 5. For heavy treatments, asphaltic cements whose penetration is greater than 150 are applied hot. Quick-breaking asphalt emulsions are also used.

The liquid tars used include the RT 5 and RT 6, while the hot application tars are the RT 8 and RT 9 grades.

For priming, MC-0 or SC-0 are used on tightly bonded surfaces; MC-1 or SC-1 for loosely bonded, fine-grained surfaces; and MC-2 or SC-2 for loosely bonded coarse grained surfaces. For priming with tar, RT-2 or RT-3 is commonly used.

The thickness of the surface treatment mat depends upon the size of the aggregate, especially when larger stone are used. Consequently the engineer may choose between Simplified Practice gradations No. 6 and No. 67, for instance, in which the maximum size stone is 1-inch; or between Nos. 7 and 78, in which the maximum aggregate size is ¾-inch; or Nos. 8 or 9, which have maximum sizes of ½-inch and ⅜-inch respectively. The Asphalt Institute recommends all of these, with 45 to 55 pounds of stone per sq. yd. for the Nos. 6, 35 to 45 lbs. for No. 67, 25 to 35 pounds for No. 7, etc. Barrett Co. recommends for use with Tarvia, Nos. 8 or 9, with the smaller size stone. American Bitumuls recommends for use with Bitumuls, an emulsified asphalt, 27 pounds per sq. yd. of ¾-inch to 10 mesh and 18 lbs. per sq. yd. of ⅜-inch to 10 mesh for chips. For tar double surface treatment, the coarse aggregate is ¾-inch to No. 8 and the fine aggregate ½-inch to No. 16.

Asphaltic limestone makes an easy-to-apply surface treatment.

Construction Procedures

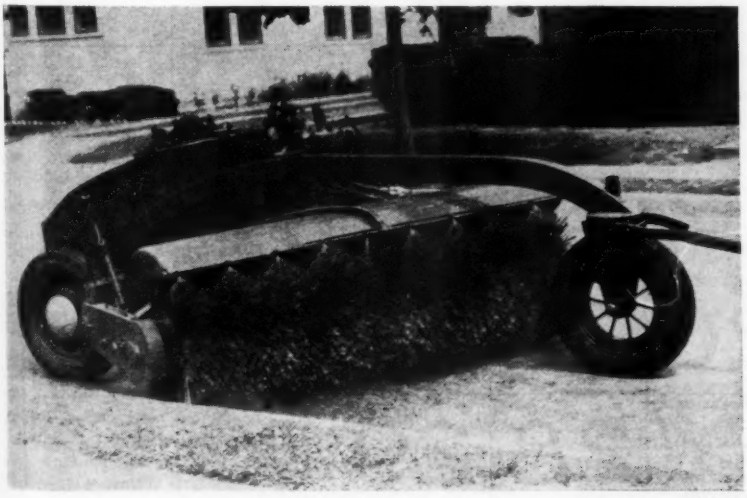
After the old base has been shaped to the proper cross-section, and swept, the prime coat is applied. Slight depressions in the surface, not removed by the preliminary preparation of the base, should be filled with aggregate to prevent ponding of the prime material. When using tar, ¼ to ½ gal. per sq. yd. is applied and allowed to penetrate for 2 to 6 hours. With Bitumuls, 0.2 to 0.3 gal. per sq. yd. is applied. With asphalt, depending on the depth of the treatment, about ¼ to ½ gal. per sq. yd. is used. Application should be with a bituminous distributor.

After the prime coat has penetrated, a second application of bituminous material is made, using from ⅓ to ¾ gallon per sq. yd., depending upon the thickness of the treatment to be applied. Immediately thereafter, cover material is applied, preferably with a mechanical spreader, and rolled with a 5- to 8-ton roller. Too much rolling, or the use of an excessively heavy roller is undesirable; the aim is primarily to set the aggregates firmly. Additional aggregate may be spread at this time and broomed into the surface, after which rolling and dragging may continue until the aggregate is firmly embedded.

The precise procedures to be followed depend to some extent on the type of bituminous material used. In general, it is desirable to follow the recommendations of the manufacturer.

Before the seal coat is placed, if used, the surface should be swept clean or loose dirt or other undesirable foreign materials. From 0.2 to 0.3 gal. per sq. yd. is applied, using RT-6, 9, 10 or 11, or Bitumuls or asphalt. Immediately following the application of the bituminous material, 15 to 25 pounds per sq. yd. of fine aggregate is applied and the surface is rolled.

The general procedure for retreatments follows that outlined above. Breaks in the old surface should be repaired and holes patched. Before applying the binder, the surface should be swept thoroughly, using power sweepers. Thereafter, the procedure is essentially as above.



Courtsy Grace Mfg. Co.

A type of broom used for sweeping prior to surface treatment.

City-County

PUBLIC WORKS

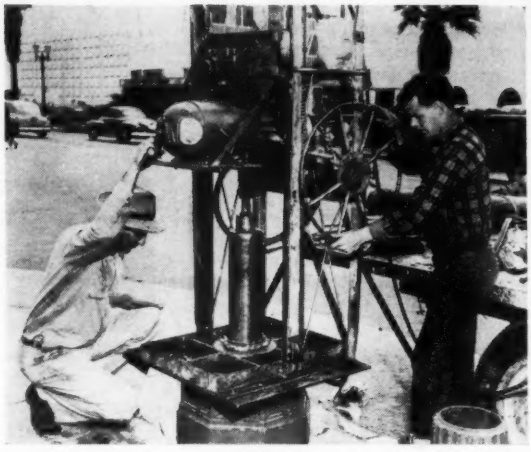
Engineering Data

A Water Works Calendar

Clarence W. Klassen, Chief Sanitary Engineer of the Illinois Department of Health, sends us a water works calendar, covering the remainder of 1948. A sample is reproduced below. This calendar is a part of the water works operation program and, according to Mr. Klassen, is "used not only as a morale builder for our operators, but also as a ready reference for important meetings and a reminder of important activities around the plant."

Drilling Through Concrete Pavement

When the city of Los Angeles decided to install new light standards, the type selected required anchoring. Holes 6¼ inches in diameter had to be cut through the pavement to a depth of 3 ft. Rotary drill bits were used, which were handmade and heat treated, then brazed to the bit shaft. The drilling action on these bits is a powdering or pulverizing one and a worm spiral keeps the hole clean. With these drills (which are made by the Rotary Concrete Drill Co.) the average 3-ft hole required only 25 minutes for drilling. The holes frequently penetrated abandoned conduits, electrical cables and pipe. The work was done by the Zeibarth Contracting Co. of Long Beach, Calif.



Drilling through a concrete pavement with a rotary concrete drill.

Water Treatment for a Chemical Plant

Specifications for the water used at the J. T. Baker Chemical Co., plant, Phillipsburg, N. J., require a

JULY · 1948

OVER THE SPILLWAY'S
WATERWORKS CALENDAR
DIVISION OF SANITARY ENGINEERING
ILLINOIS DEPARTMENT OF PUBLIC HEALTH

SUN	MON	TUE	WED	THU	FRI	SAT
WATERWORKS PROGRESS 1832 1ST FILTERS IN U.S AT RICHMOND, VA. 1897 USE BLEACHING POWDER TO STOP TYPHOID 1930 - ACTIVATED CARBON 1ST USED BY W.W.HS.		! SECTION MEETING COMING ! NORTHWESTERN ILLINOIS OPERATORS CLIFF MOOMAU - PRESIDENT SPENCE MERZ - SECRETARY		1 35TH BIRTHDAY IRON-REMOVAL TREATMENT PLANT CHAMPAIGN-URBANA	2	3
4 INDEPENDENCE DAY -- UP GOES THE FLAG	5	6 "ANDY" ANDERSON MOLINE	7	8	? RED WATER ? 9 FLUSHED YOUR HYDRANTS RECENTLY ?	10
11	12	13	14 SUNNY WEATHER COPPER SULPHATE WATER SUPPLY RESERVOIRS EVERY 10-14 DAYS	15	16	17 DON'T TREAT WITH $CuSO_4$ WHEN RESERVOIR SPILLWAY IS DISCHARGING
18	19 GUIDE FOR CONTROL OF CORROSION IS FREQUENT USE OF THE STABILITY (MARBLE) TEST. (CALCIUM CARB. STABILITY)	20	21	22 DO YOU KNOW THE DESIRED pH OF YOUR WATER FOR STABILITY ???	23	24 MARISSA'S "PHIL" TRIEFENBACH
25 CLYDE "LITTLE EVA" HUM	26	27 40°F. WATER AT pH 8.5 REQUIRES AT LEAST 1.0 PPM RESIDUAL OF COMBINED CHLORINE FOR DISINFECTION	28	29	30	31 FREE CHLORINE RESIDUAL IS DESIRABLE FOR MOST TREATED WATERS

Sample page of the Illinois Department of Health Water Works calendar.

total ionized solids content of not more than 4 ppm. The raw water available contains a total of 151 ppm, 17 of which are silica. In the past distilled water was used, which cost $5 per 1,000 gallons. An American Cyanamid water demineralizer was installed and produces a water which, in terms of total ionized solids, is better than the triple-distilled water previously used. The cost per 1,000 gallons totals 26.5¢ for operation. Chemical cost, per 1,000 gals., is 13¢, labor 3.5¢ and raw water 10¢. The resulting saving is approximately $757 per day and the installation is expected to pay for itself in 3 months operation at rated capacity. Operation is almost entirely automatic.

Old Oil Used by Milwaukee Garbage Plant

John Hubel

The city of Milwaukee makes good use of the old oil that is drained from cars at service stations. It is used to aid in burning the city's garbage. The city has a 600 gallon tank truck for collecting the old oil from the service stations, calling on about 200 stations for that purpose. It is estimated that about 700 tons of the old oil are brought to the garbage plant annually by the truck. A 1,000-gal. reservoir is available for oil storage at the incinerator plant.

The plant manager states that the burning of garbage was not the original purpose in collecting the old oil from the service stations; it was done originally to keep the service station operators from pouring the old oil drained from cars down the city sewerage system. This, as can be realized, would be tremely dangerous, in view of the amount of gasoline and kerosene mixed with the oil in car crank cases.

Cost of Laying Water Pipe in Little Rock, 1947

The annual report of the Little Rock, Ark., Municipal Water Works, for the period ending Dec. 31, 1947, contains some cost data on water pipe laying. There were 40,870 ft. of 2" wrought iron and steel extension which, with 77 valves, cost $40,908, or almost precisely $1 per ft. Labor was approximately 45% of the total. Other pipe laying costs were: 2" cast iron, 1,188 ft., 3 valves, 58¢ per ft.; 3" c.i., 515 ft., 2 valves, $2.15 per ft.; 11,523 ft. 6" c.i., 39 valves, $2.96 per ft., of which about 46% was for labor; 14,615 ft. of 8" c.i., 42 valves, $4.00 per ft.; 11,661 ft. of 12" c.i., 33 valves, $6.53 per ft.; 10,174 ft. of 12" Transite, 31 valves, $3.50 per ft.

A New Idea in City Reports

The 1947 annual report of the City of Wichita, Kans., presents some new ideas that other cities might consider. There are two daily newspapers in Wichita, and the report was published as 8-page tabloid-size Sunday sections of these newspapers. This gave a total distribution of about 115,000 copies. In one paper, a magazine style of make-up was used; in the other, a news style. The cost was only slightly greater than was formerly spent in issuing 7,500 copies of the standard 6"x9" 48-page report. The staff of the City Manager, Russell E. McClure, prepared all of the copy, provided the photographs and made the layouts. The result is an informative and readable report that should create public interest in the activities of the city government.

JAEGER

announces

"new standard" size

AIR COMPRESSORS

that do

40% more work at the same price

"new standard" model 75 cfm replaces old model 60

"new standard" model 125 cfm replaces old model 105

"new standard" model 185 cfm replaces old model 160

"New standard" Model 125 runs 2 big breakers or 3 medium breakers at full 90 lbs. pressure (40% more efficient) yet sells at old "single breaker" model 105 price. All other sizes are comparable.

"new standard" model 250 cfm replaces old model 210

see them at the

ROAD SHOW

or see your Jaeger dealer or send for new Catalog

"new standard" model 365 cfm replaces old model 315

"new standard" model 600 cfm replaces old model 500

THE JAEGER MACHINE CO., Columbus 16, Ohio

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ERNIE SIMONS
Manager

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350 ROOMS from $2.50

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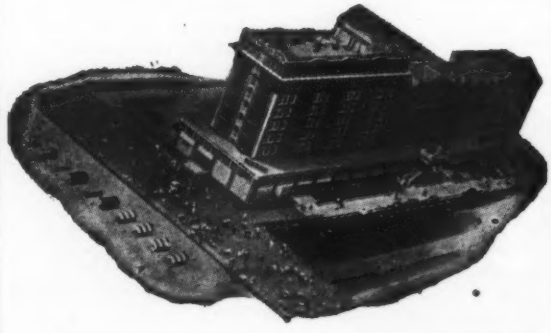
ST. LOUIS MISSOURI



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A Hotel Planned and Designed for Your Every Comfort . . . assuring you absolute Rest and Relaxation . . . amid an Atmosphere of Refinement . . .

Beautifully Furnished Rooms . . . Ocean Front Verandas . . . Roof-Top Solarium . . . Salt Water Baths . . . Cuisine Unsurpassed . . . Garage on Premises . . .

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EXCLUSIVE PENNSYLVANIA AVENUE & BOARDWALK
ATLANTIC CITY, N. J.

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Melting Snow from Runways

A machine is described in *Airports*, which consists of fuel oil combustion units and a 12-ft. x 4-ft. combustion chamber, mounted on the front section of a grader. A squeegee blade, 15 ft. long and 18 in. high is mounted at a 30° angle at the rear. Snow and ice are melted by a 2,000°F. flame blast. The machine weighs 11 tons, requires two men for its operation, proceeds at a pace of from four to fifteen miles an hour according to the depth of snow to be removed, and can keep a typical 5,500-ft. x 150-ft. runway clear of snow at an operating cost of about ten dollars per hour. *Aerodrome Abstracts.*

Spring Road Failure Study

An exhaustive study of the causes of spring road failures is under way in Virginia. The winter of 1947-48 was a very severe one, with deep freezes. More than 100 men were sent into the field when the spring thaws came and the performance of every road section, surfaced or unsurfaced, was determined on the following basis: Excellent—smooth, with no failure; good—only slight failure; slight distress—not more than 5% failure; secondary distress—5% to 20% failure; and primary failure—20% or more failure. The results will be correlated to road types, soil areas, traffic density and certain other variables.

Construction Machinery Production in 1947

Shipments of excavating and earthmoving equipment during 1947 were valued at $437 million, according to the Bureau of the Census, Dept. of Agriculture. Of this total, $304 million represents excavating and earthmoving equipment other than power cranes and shovels; and 75% of this went to the domestic market.

Total shipments were as follows: Ditchers and trenchers, 948; carrying and hauling scrapers, 6,341; graders, 9,904; rippers and rooters, 963; rollers, 4,193; shovel-type loaders, 5,444; dozers, angle and bull, 17,227; tracklaying tractors, 37,624; heavy-duty wheel tractors, 4,867; power cranes and shovels, ⅜ to 2½ yards, 8,035.

Damage from Inadequacy of Drains

A city is not liable for damage to private property by surface water due to the inadequacy of its drains where the property damaged is the natural depository of all the water discharged thereon. Roche v. City of Minneapolis, Minnesota Supreme Court, 27 N.W. 2d 295. The evidence in this case did not show that the city unnecessarily discharged surface water on the plaintiffs' land where it did not naturally belong. The drop in the storm sewer from the plaintiff's house to the normal level of the lake into which the storm sewer drained was four feet. It was held that the plaintiffs could not claim damage from the flooding of their basement on negligence of the city in maintaining a submerged outlet which allegedly retarded the flow through the drain, since an above surface outlet would have reduced the fall and slowed the flow of water through the drain even more. The competence of the engineers who planned and constructed the city's system of streets and sewers was not questioned.

Hawaii's Amazing Water System

NO STORY of Hawaii's progress can quite match the amazing development of its water system, for it is this development which is the literal and figurative fountainhead of the agricultural and industrial progress which has turned these few islands into a major American asset populated by more than half a million persons.

The first unit of a water system in Honolulu, installed, operated and paid for by the government, was in service in 1848. This was "a water tank for the convenience of shipping" which was placed in the basement of the Harbor Master and Pilot's office. The water was supplied through a lead pipe and the total construction cost was $2,647. The wording of this quotation dates the installation to the time when whaling was the backbone of local industry.

Existence of artesian areas in Oahu was proven some 30 years later. Previous to this development, the entire coastal area was a dry plain, and agriculture prospered only in the stream valleys. The discovery of artesian water has resulted in the development of the great plantations which cover a large part of the island. The collecting area of the artesian supply, covering 25 sq. miles, lies in the mountains 4 to 6 miles back from the city of Honolulu, and at an elevation around 3,150 ft. Part

Laying 42" C. I. pipe.

of the rain water falling on this area seeps downward through porous lava formations, finally finding its way into strata which lie below the caprock. This caprock is a thick layer of impervious soil which, at the coastline, is 1,000 to 1,200 ft. thick, but extends along the ocean floor a considerable distance out to sea.

Captured and confined by this formation, the continuous downward flow of water through the mountain strata creates sufficient pressure to force it up through deep, small bore artesian wells, drilled through the caprock, to an elevation of 25 feet above sea level. Salt water from the ocean also seeps into the porous lava underlying the caprock. However, as salt water is heavier than fresh water, the rain water from the mountains floats upon, or is "perched" upon, the ocean water.

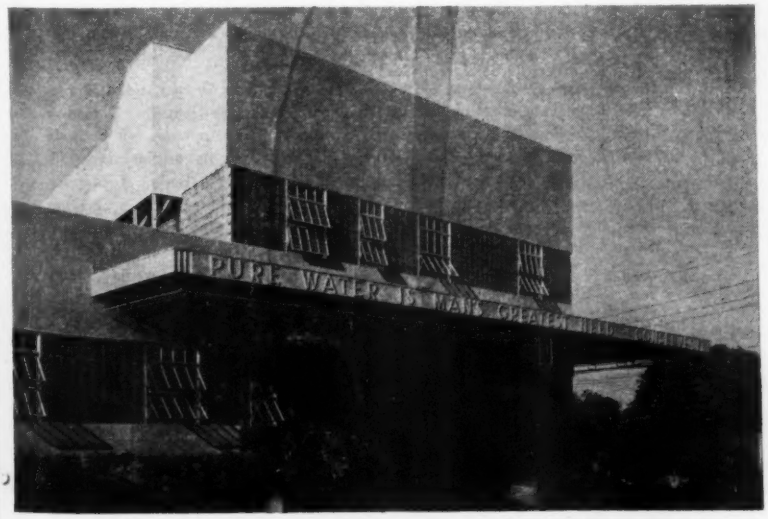
It is a generally accepted engineering theory that for each foot of fresh water in the artesian area above sea level, there is an extension of 40 feet of fresh water below sea level. Therefore, Honolulu's present artesian head of 25 feet indicates that fresh water in the porous lava goes down about 1,000 feet before reaching salt water.

About 55% of the water now produced by Honolulu's public system comes from 25 artesian wells, 200 to 600 feet deep, and is forced through the mains into the reservoirs of the distribution system by three steam pumping plants, all located within the metropolitan district. These stations now produce and distribute about 20,000,000 gallons of water every 24 hours.

However, because of the great depth of the small bore artesian wells, there is a constant danger that lowering of the artesian head, or level, might cause destructive intrusion of salt water. Frederick Ohrt, manager and chief engineer of the Board of Water Supply, executive head of the municipal water system since 1925, and the man principally responsible for the design and creation of the existing system, is authority for the statement that deep artesian wells are becoming obsolete and that in from 5 to 10 years they will be sealed and abandoned and will be succeeded by underground pumping stations.

The three underground stations now in existence are at an elevation of about 165 feet above sea level, and therefore above the caprock. Inclined shafts are driven down to the water surface, generally about 25 feet above sea level, where electric pumps are installed, and water is gathered in horizontal collection tunnels which are driven into the water-bearing lava strata at about sea level.

These are called "skimming" tunnels because they take the fresh water from the top of the artesian supply rather than from near the bottom. The water is from the same source as that which supplies the deep artesian wells, namely the rainfall on the mountain watershed, but being tapped from an elevation above the caprock extension it does not rise to the surface from pressure but must be pumped.



Beretania St. Pumping Station and executive and administrative offices in Honolulu.

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A condensation of a paper before the Highway Research Board by Leon Corder, Senior Maintenance Engineer, Missouri State Hwy. Dept.

Control for Low-Volume Intersections

PROBABLY no phase of traffic control has been subjected to such close scrutiny as that affecting road and street intersections. In Missouri, the Highway Department's expenditures for intersection control devices represents the largest single amount expended for traffic control, but 27% of highway accidents still occur at cross roads. Great progress has been made in controlling traffic at intersections of city streets, but in rural areas, intersections below the stop-and-go signal level have generally been treated haphazardly and with a startling lack of uniformity. Too often, engineers in the field of rural traffic control have attempted to meet this problem by adopting urban treatments, which are generally too elaborate and expensive to be warranted in such areas, rather than develop a system suitable for meeting their own conditions.

What Is a Rural Intersection?

The rural intersection in the midwest may be roughly defined as one which averages approximately 750 vehicles per hour, for the six heaviest hours (not necessarily consecutive), entering from all approaches. The 6-hr. average is taken in preference to the customary 8-hr. because low-volume rural intersections seem to exhibit peak periods that are shorter and less pronounced than in the case of urban traffic.

The Missouri State Highway Department has attempted to develop methods of intersection control graduated to meet the various conditions of traffic volume. Listed in order of increasing importance, and with some thought being given to the installation cost, these methods are as follows:

1. 30" *stop signs* on the less important route; no controls on State route.

2. 36" *stop signs*, preceded by "*Stop Ahead*" signs on the less important route; "*Cross Road*" or "*Side Road*" signs on State route.

3. Same as No. 2, but with the addition of an overhead flashing beacon, showing red flashes on the less important route, and amber flashes on the more important route.

4. *Four-way stop* installation, using 36" or 48" stop signs, each being preceded by a "*Stop Ahead*" sign.

5. Same as No. 4 but with the addition of an overhead flashing beacon showing red flashes for all approaches.

6. *Overhead suspension* pre-timed combination signal-flashing beacon, which operates stop-and-go during peak periods, and as a flasher at all other times. Flasher to show red-amber indications when one route produces 30% or less of the traffic and all red for all other percentages.

7. Regular traffic signal installations.

Where These Will Be Used

Defining warrants for these several methods was a difficult undertaking for the Highway Department. The results obtained, though not completely satisfactory, are to be published in a "Manual of Uniform Traffic Control Devices." Of the several warrants applied to the selection of traffic signals in general, there appeared to be only two which basically could be applied to the ordinary variety of rural intersection—"minimum vehicular volume" and "interruption of continuous traffic."

Treatment No. 1 is designed for a top volume of 75 vehicles per hour (total on both routes combined) at intersections where the traffic on the minor route is more than 25% of the total, the volume increasing to 400 total vehicles as the minor route traffic approaches zero.

Treatment No. 2 is for intersections where the total volume is between 75 and 200 vehicles per hour and the minor route percentage is between 30% and 50%. However, as the minor route decreases in importance, the total volume may increase to almost 1,500.

Treatment No. 3 is for intersections where the total volume is between 200 and 400 vehicles per hour with 40% on the minor route; rising to almost 2,000 per hour as the minor route percentage decreases.

Treatment No. 4 may be used where the so-called "minor" route (as distinguished from a State highway) creates calls for entry above 50% of the total traffic. (This is being tried out in a few locations where the total volume entering the intersection is between 75 and 200 vehicles per average hour.)

Treatment No. 5 is for use where the so-called "minor" route produces at least 40% of the total traffic, which may be between 200 and 400 vehicles per hour.

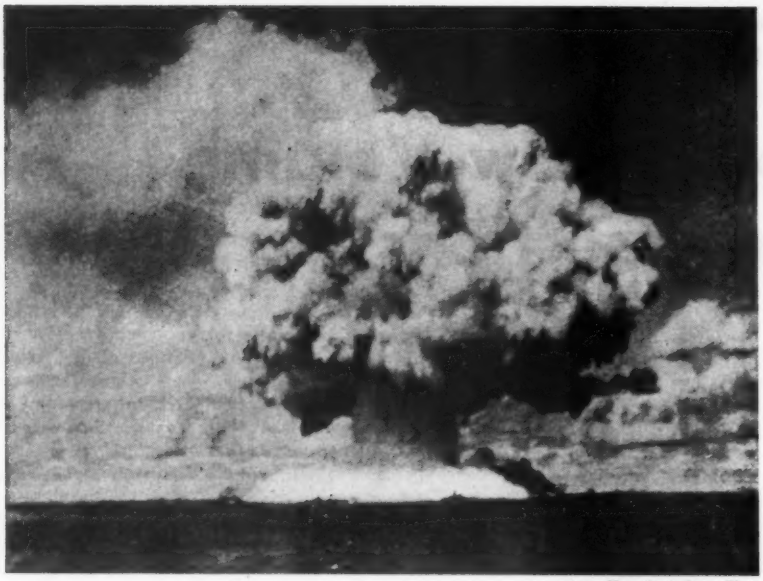
Heavy Traffic Intersections

Treatment No. 6 is for intersections with a total volume of 400 to 1,000 per hour. It may be used for total vehicular volumes as low as 400 per hour, even though the non-State highway produces as much as 80% of the traffic. This, in the face of very sketchy supporting data, has been done to give the State highway some slight advantage over the non-State route. Units installed so far have been located where the State route exceeded the other route in traffic volume. When the unit is operating as a stop-and-go signal, its cycle is so timed as to take into consideration the relative traffic volume produced by each route. When the peak hours have passed, and the hourly traffic falls below 400 vehicles, the unit is set to change automatically from a stop-and-go signal to a flashing beacon. When one of the routes produces 30% or less of the total intersection volume, that route receives the red flash for a stop; and the other, more important route, an amber flash for caution. On the other hand, when the lesser route produces over 30% of the total traffic volume, the intersection becomes a four-way stop with an all red flashing beacon, exactly like treatment No. 5.

Intersection Delays

It might be well to go into some of the reasons for making use of a four-way stop—an installation that has, for some time, been in disrepute. The over-all flow of traffic is, without question, slowed down by such an installation. However, with total intersection volumes of 400 vehicles per hour and less, this delay is not con-

(Continued on page 60)



Army-Navy Task Force Photo

Cloud formation at peak in underwater explosion.

What An Engineer Should Know About Atomic Bombs

Air-burst atomic bombs will produce lethal effects over an area of 2 square miles and measurable effect over an area of 7 sq. miles. In underwater explosions, radioactive fission products and unfissioned materials may be spread over even a wider area.

THE one factor that makes the atomic bomb detonation different from all other detonation-type weapons is the nuclear radiation produced. All high-explosive weapons produce high temperature and high blast pressure, and the only difference *in these respects* between atomic and conventional weapons is the increased magnitude of the blast and much greater thermal effect of the atomic bomb. However, no other weapon releases nuclear radiation.

The bombardment of fissionable material by neutrons (which causes the detonation) results in the formation of two fragments known as fission products. All nuclei do not split into the two type of fragments; therefore many radioactive substances, called fission products, are liberated. The sum of the masses of these fission products will not equal the original mass of the split nuclei. The difference between the fission products formed and the original mass represents the mass of nuclei that has been converted into energy in the form of blast, heat, light, x-rays, gamma rays and released nuclear particles.

Action of the Bomb

Detonation of the bomb generates a crushing wave of high pressure, and liberates an enormous quantity of electromagnetic radiations and neutrons. The electromagnetic radiations include infra-red, visible light, ultraviolet, x-ray and gamma radiations. The fission products emit gamma rays and beta particles. The unfissioned residue emits alpha particles. The range of neutrons is negligible at 1000 yards because of absorption by the air. In an underwater burst, greater absorption occurs, resulting in induced radioactivity of the water. However, this applies to sea water almost exclusively because of the sodium content (sodium absorbs radioactive substances), and this is hazardous for only a limited time because of its short half-life (14-8 hours). Fresh water will not be seriously contaminated.

Climatic and meteorologic conditions affect largely the diffusion, dispersion and radiation activity of the cloud. The fissioned and unfissioned material in an airburst will be distributed into the air; while in an underwater burst, the water and the land or other objects that the spray of salt water falls on will be seriously contaminated. The fission products deposited from either the water cloud or the air will contaminate nearby areas and will present a health hazard for a considerable time after the explosion. Changes in temperature, chemical interactions, or strong magnetic or electric fields have no effect on the rate of transformation or emission characteristics of the radioactive substance. It must decay normally.

The four known kinds of penetrating radiation that can be expected within the immediate area of the blast are: (1) Gamma radiation, which is essentially the same as x-ray radiation of 200 million volts; this radiation is lethal for about half a mile, dangerous to 1½ miles, and limited to 2 miles; (2) Neutron beams, which have slightly less range than gamma rays; (3) Beta rays, which rarely penetrate the skin, but may affect its surface; and (4) Alpha particles, the nucleii of helium atoms, which do not get through the skin and which, like the beta rays, are not likely to cause fatal damage.

Effect of the Bomb

The heat from an airburst flash occurs in a very short interval of time; the temperature of the skin can be raised 50° C by the flash of infra-red and violet rays during the first millisecond at a distance of as much as 2½ miles, and there may be flash burns at greater distances. Gamma radiation danger does not extend nearly so far, and the neutron danger zone is still more limited. For personnel in the open, it is probable that those within one-half mile of the burst-point would be killed; those more than a half mile, but less than a mile distant would suffer seriously, and there would be some fatalities. Ordinary houses would suffer complete destruction and there would be many fires. Between 1 and 2 miles, personnel would be injured by flash burns and indirect blast effects. Between 2 and 4 miles, structures would be seriously damaged and personnel would be injured superficially. Flash burns will not be a factor in underwater explosions.

The detonation of a bomb over a modern city containing numberless items of iron, copper, zinc and other "neutron capture materials," might

(Continued on page 60)

Dams in PERMAFROST

By JOSEPH D. LEWIN

This is the fifth article in this series and the third on the design and construction of dams in areas where the ground is permanently frozen. Illustrations are shown on page 33 of the June issue.

Spillways on Permafrost

Discharge of flood waters presents a difficult problem in the permafrost region. However, the fact that flood flows in arctic regions are smaller than for similar conditions in the temperate zones permits a reduction in the required spillway capacity. Where masonry dams can be erected, spillways of normal types can be provided. Attention should be paid to ice thrust and to means of reducing it. Furthermore, the designer must decide whether to pass the ice over the spillway, or to store it in the reservoir and to allow it to thaw. Since the ice insulates the water in the reservoir from solar radiation, thereby keeping the water temperature low, storage of ice in the reservoir will protect against defrosting of the permafrost. Therefore, it is well to consider the question of ice retention in the reservoir, before deciding upon sluicing ice.

For timber dams, the spillway problem is comparatively simple, since this type of dam can be overflowed. Nevertheless, the downstream flood bed should be well protected against the erosive action of spillway discharge.

For earthfill dams, removed spillway locations are preferred, provided a site suitable for building a concrete spillway structure can be found. However, if no site is available where the ground can support a concrete structure alternate methods are available. The overflow can be discharged through either a tower intake or a morning glory intake, on pile foundation, and conveyed to the tailwater of the dam through a pipe conduit or tunnel. The conduit or tunnel must be flexible enough to withstand differential settlements of the ground. Intake towers will require considerable pile foundations; they can however, be built on an inverted caisson or on a floating foundation.

For low-head reservoirs, a concrete overflow section can be built on pile foundations, similar to those for low dams on granular soils. Such an overflow section requires an upstream cut-off to insure against seepage and piping, and a downstream protection against erosion by the discharged waters.

For high-head earthfill dams, the spillway can be built by extending the upstream protective blanket over the crown and the downstream face of the earthfill. Particular attention should be paid to details of watertightness of such a blanket and to its expansion facilities. In most cases the earthfill will not be stable enough to support regulating gates or piers. Therefore, water level control can be provided by installation, at the crest, of a beartrap type dam whose two leaves will collapse into a recess at the crown, allowing the water to discharge over them. To operate the leaves of the beartrap arrangement, an operating and inspection gallery can be incorporated in the dam just below the recess at the crown. If this type of design is chosen, the spillway should be operated in sections, the division into independent sections providing for spillway flexibility.

Methods of Reducing Settlement

In order to decrease the rate and the amount of ground subsidence under a water storage dam, several methods can be applied. Most methods are based substantially on two principles—the ground can be consolidated previous to construction, or it can be undercooled and maintained in a permanently frozen state.

The preconsolidation of ground requires defrosting of all ice inclusions, removal of moisture, and filling of the voids with stable materials such as cement grout, asphaltic or bituminous grouts, or sodium silicate grouts. An alternate method consists of consolidating the thawed ground by tamping, blasting, or vibration. In this connection, modified vibroflotation, as mentioned above, is of considerable value.

If the soil is of clayey or silty character, however, so that neither draining nor consolidation is feasible, it can be maintained in a frozen state. The earthfill in itself contributes to preservation of permafrost, since it provides insulation aganst warm air. Furthermore, aeration of the gravel layer at the base of the earthfill during the winter season contributes a cooling effect upon the foundation. Finally, aeration ducts can be inserted into the ground in order to underfreeze it. (8)

Construction Methods

Concrete dams are built in accordance with normally accepted procedures. Timber, rockfill, and earthfill dams require special methods.

To prepare the foundation for an earthfill dam, the vegetation cover and any other undesired strata are removed. If this is done during the winter season no additional precautions are necessary. For summer work, the exposed ground should be covered immediately with gravel fill (to protect the permafrost) unless it is desired to defrost the ground. If aeration ducts are to be installed they should be placed through the gravel fill, thus utilizing its protection.

After the base course is placed, the earthfill is placed in layers and compacted to its optimum density. The completed earthfill should be left for at least one summer before placing the inclined gravel layer. After the gravel layer is placed, the insulation, waterproof blanket, and protective facing are placed successively. It may be desirable to let the dam stand through another summer before placing the protective facing, so that any repairs to the waterproofing blanket may be made before it is covered up.

The completed dam should stand for at least one winter before the reservoir is filled. To insure that the

permafrost table has been raised and that the aeration system works satisfactorily, thermometers (thermocouples) should be placed at critical points and the temperature observed and recorded daily. Filling of the reservoir should be permitted only after the temperatures in the dam are sufficiently low. Also, the reservoir should be filled just before the frost season starts, if possible, so as to have the advantage of an ice cover as soon as possible.

Summary on Design

Any dam built on permafrost should satisfy eight basic criteria:

1) Flexibility, to withstand subsidences of the ground;
2) Low conduction of heat from the atmosphere into the ground;
3) Sufficient thickness and insulation to prevent freezing temperatures from reaching the reservoir;
4) Dryness of the dam body, as protection against freezing damage;
5) Water-tightness under temperature differences of 160°F;
6) Resistance to severe ice thrust;
7) Resistance of component materials to severe climatic conditions; and
8) Low shear stresses in the foundation.

Gravity type dams are feasible on frozen rock formations. Single arch dams and articulated dams (buttress-type) are not suitable because of the thinness of their shells. Timber dams, rockfill dams, and earthfill dams are feasible, each in its proper field and height. Timber dams are suitable for low heads and can be built very economically. Rockfill dams can be built wherever coarse aggregates can be found. Earthfill dams are feasible on fine grained soils and can be constructed at reasonable cost.

Earthfill dams should consist of dry earthfill, protected from the main dam body toward the upstream face, successively, by:

1) A gravel layer affording winter aeration
2) A flexible thermo-insulation layer
3) A flexible waterproof blanket
4) A protective cover or facing.

The downstream face should be protected against erosion.

To reduce settlement, the ground can be either preconsolidated or retained in a permanently frozen state.

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Is Forestry on Municipal Water Sheds Financially Profitable?

THE Hartford, Conn., Metropolitan District Water Supply owns 2656 acres of forest plantation, planting on most of which was begun in 1917. The question arose as to the policy to be adopted for the future of these plantations, and Caleb Mills Saville, Manager and Chief Engineer, has submitted a report based on facts and opinions obtained from several New England cities which have developed forestry projects and from federal and state forestry experts. This information he summarized as follows:

"An intensive forestry program must result in considerable expense that shows no financial return for a decade or so, and for a score or more years thereafter, little positive income. After 35 or 40 years there may be substantial return leading up to a fixed annual income of value. As far as our studies go, there seems little or no difference in net results from the wild forest and one that has been given ordinary attention for protection. This applied to forested areas starting at scratch or those recently logged clean. Where standing forests 35 or more years exist selected cutting of matured trees probably will yield annually a return of about a hundred fbm per acre per year from mixed growth. Clear pine or other conifers will yield more under competent supervision. Forest cover is both a help and a detriment to watershed land. Conifers shade the ground from sun and delay run-off; on the other hand their branches hold the snowfall which evaporates without reaching the ground. By and large it appears that mixed scrub, following a cleared out area, especially where seed pines are left, is about as effective and of less expense than planted forests. Open pasture may well be planted to pine but thereafter let nature take its course, do not nurse the little trees by clearing wild growth around them; if they can not survive by themselves, it is too bad. Expense of clearing is not warranted."

On the basis of this information he concluded that, "in Southern New England at least, if all expenses are considered, including amortization of costs of land, financial profit therefrom is very small if not indeed negligible. If, however, cost of land purchased for water supply protection and certain other expenses as taxes and similar carrying charges, are charged off to water supply and protection of the investment, it may be possible as a matter of bookkeeping to indicate a financial return which can be termed profit. This statement applies to privately owned forest areas as well, if no value is placed on owners' time and equipment. In other words, there seems no profit in the development of a forest area as a purely commercial venture in spite of enthusiastic press articles that appear from time to time released as propaganda to stimulate interest in forest extensions and perhaps keep intact government personnel. Undoubtedly a good work may be promoted and a valuable but intangible asset accrue to state and national wellbeing by such work, but not because of financial gain within the immediate future. . . . As a pure and simple financial matter, any return from sale of present forest products will produce much greater returns if the money is put into interest bearing securities than if reinvested in forestry.

Three methods of approach to this problem of forestry conservation seem feasible, if it is decided to proceed therewith:

1. Do nothing—let nature take its course. Result: Meager returns.
2. Do as little as possible to conserve the investment. Result: Same meager returns but a better forest, and in time, a more productive one. This plan is recommended.
3. Enter on an intensive forestry program to obtain as great a product yield as possible. Result: Loss financially except for future value and probably returns never as great as expenses."

Matching the Deepwell Turbine with the Well

The following paper, which was presented at the meeting of the National Association of Vertical Turbine Pump Mfrs., will simplify the selection of turbine pumps and should be helpful in solving well water supply problems.

L. C. KIMBALL

TO OBTAIN a good well, a competent well driller familiar with the geological and water conditions in the local territory should be engaged. Although the "type" of well may vary in different localities, it is advisable to follow the recommendations of the driller in this matter. A good grade of heavy casing should be used, so fabricated that during the process of drilling, a rigid alignment can be obtained by the driller, resulting in a straight and relatively plumb well. A well which is slightly off plumb *will* permit operation of a deepwell turbine pump, but a crooked well can cause disastrous results, due to misalignment of the column and line shaft.

The well should be of ample diameter to allow such clearance around the bowls that small gravel, or other foreign objects cannot lodge between the bowls and the well casing. Future difficulty in removing the pump and possible damage to the well may result from such a condition.

Perforation at water bearing strata should be, whenever possible, below the anticipated water level in the well while pumping. When perforations are made above the pumping level, they are apt to cause cascading water, which tends to entrain air resulting in inefficient performance of the pump.

The owner should see that an accurate log is kept by the driller, recording the various strata encountered, length of casing, and levels at which the well is perforated. Should it ever become necessary to revamp the well, due to changing water conditions, or other causes, this log may prove invaluable after the well is completed.

Developing the Well

After completion, the well should be developed by the use of a test pump for the purpose of removing sand and determining the yield of water. The test pump should be capable of producing a greater capacity than that anticipated in the permanent installation, in order to remove sand to the greatest possible extent. With such over-development, the permanent installation of a small capacity pump will have little sand to handle, resulting in reduced wear on the pump. If the test shows insufficient water, additional drilling operations may be required to obtain the necessary yield.

After the full capacity has been obtained from the well, the test should be carried on for a considerable period of time to eliminate the possibility of local conditions interfering with the true flow of the well under continuous operation. On completion of the testing, a chart should be made, showing the actual drawdown of the well plotted as a function of the yield, as shown in Fig. 1.

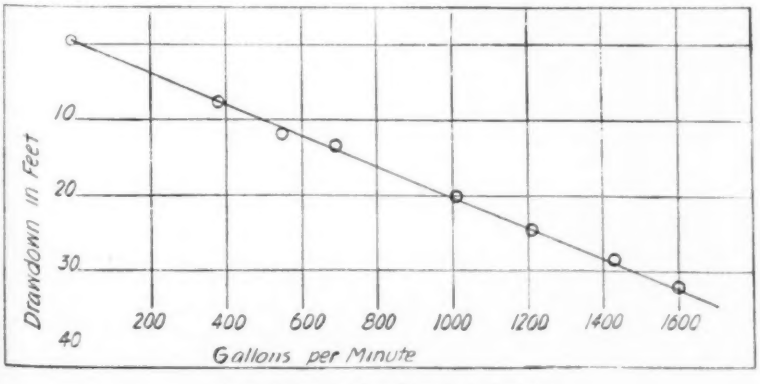


Fig. 1. Results of drawdown test of well.

In conducting the test for the drawdown chart, it will be necessary to make a capacity measurement by means of a weir, orifice, pitot tube or other suitable device, and obtain the drawdown with a detector line, electric sounder or detector hose.

Selecting the Pump

With these data available, it is possible to make a correct selection of a deepwell turbine pump which will have a performance meeting the required conditions. In order to insure that this performance shall be maintained, all possible care should be given to the study of changed conditions which may exist in the future, due to lowering of the water table, very common in territories irrigated from underground strata.

To arrive at proper conclusions, it is advisable to lay out the well conditions on the pump performance curve, so that the owner may visualize more readily the final results. To illustrate this, Fig. 2 shows the performance of a 12″ 2-stage, 20 hp, 1,750 rpm unit having a bowl diameter of 11¼″ and equipped with 50 ft. of 8″ standard pipe outer column, 2″ inner tubing and 1 7/16″ line shaft. These charts show a combination of pump performance, well drawdown, and discharge line characteristics plotted by two methods.

In the example, the pump has a capacity of from 800 to 1,000 gpm, installed in a 14″ well, with drawdown characteristics as shown in Fig. 1; and must deliver water 5 ft. above the ground surface, pumping through a discharge pipe line having a friction curve as shown on Fig. 2. Under test, the depth to static water level in the well was 25 ft. The drawdown, as per Fig. 1, was about 2 ft. for every 100 gpm pumped.

By referring to Fig. 2, it will be noted that we have plotted, first, at 5 ft. the static head above ground surface and at 30 ft. the sum of this 5 ft. and the 25 ft. static level in the well. Starting from this 30 ft. line, the well drawdown curve is plotted from Fig. 1, which, at the 1,000 gpm point shows a 20 ft. drawdown, giv-

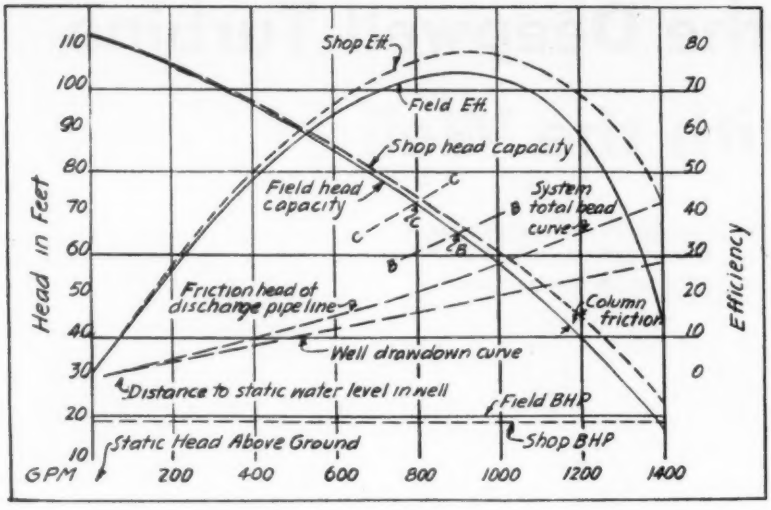


Fig. 2. Pump performance data.

ing a 50 ft. total. Added to this well drawdown curve is plotted the friction curve of the discharge pipe line, which also shows at varying capacities the total head of the system.

This system, comprising a well and a pipe line, has one and only one capacity at one head. The total *system head* curve shows from zero to maximum capacity the corresponding heads of the system, and its intersection with the field pump performance curve determines the operating point of the pump, in the example 1,000 gallons, 58 ft. No pump can be made that will deliver 1,200 gallons, or in fact any other capacity than 1,000 gpm, on this system at a 58 ft. head. It is the *system* that determines the head at any given capacity. For a larger capacity than 1,000 gpm, the head will be higher, and for a lower capacity the head will be lower.

If the system characteristic changes due to a general lowering of the water table or other causes, the starting line of 30 ft., Fig. 2, or the drawdown curve of Fig. 1, or the friction curve or any or all will change. The total system head changes at all capacities. Such possible changed system heads are plotted as lines BB and CC on Fig. 2, intersecting the pump characteristics at points B and C, giving heads of 65 and 73 ft., respectively, at capacities of 900 and 800 gallons. The field efficiency curve shows a practically constant value over this range; therefore, if the anticipated facts are correct, the pump selection is satisfactory.

In another method of layout leading to the same conclusions, the system is plotted in two parts as it exists in the field above and below ground surface, the discharge line friction curve giving the total head characteristics of the system above ground surface.

The Atomic Bomb

(Continued from page 56)

result in some residual radioactivity. However, residual radioactivity is of little importance except in the area close to the center of a low altitude airburst; no large area will be affected. In the case of an underwater burst in salt water, the effects would be more serious, especially if the wind were blowing. In such cases, radiation might be lethal for as much as two miles downwind, and dangerous for considerably greater distances, due to the radioactive sodium carried by the cloud of spray.

Water and Food Contamination

While local water supplies are unlikely to be seriously contaminated by an atomic burst, it is better not to use water from an area severely affected by the explosion, at least not immediately. Water protected by concrete will probably be unaffected. There is no known method of treating water that has been contaminated by an atomic bomb explosion. Boiling is useless. Storage is of benefit for short-lived isotopes, but of little value for those with long lives. Filtration and coagulation to remove sodium, calcium, and other neutron capture materials is of some value; but chlorination is not of value.

Foods protected by cans will generally not be affected but care may be necessary in removing the food from the cans. In general induced radioactivity in the food will not be serious enough to be dangerous, but radioactive substances may have been deposited on it by the detonation. Food brought into the area will require protection against contamination by such substances.

Aside from bursts in salt water, where a radioactive spray may affect streams, the most serious problem in stream sanitation arises from the discharge of wastes from atomic manufacturing plants. These wastes are extremely difficult or impossible to denature completely, with our present knowledge, certainly by any short and quick treatment process.

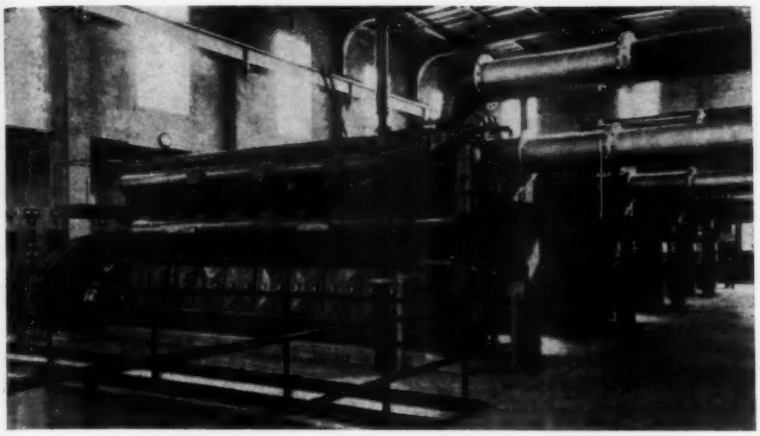
The data on which this article is based were obtained from a series of articles prepared by the Special Projects Division, Office of the Surgeon General, Department of the Army, and published in the *Bulletin* of the U. S. Army Medical Department.

Low-Volume Intersections

(Continued from page 55)

sidered serious unless consecutive intersections in close proximity are so treated. Such a situation, however, would be more the exception than the rule, and would undoubtedly require special progressive treatment. In this low grade intersection field, therefore, experience has indicated that the four-way stop has a place, and that it does without doubt relieve confusion, eliminate (if properly installed) certain types of accidents and (to a certain extent) assist in the control of approach speeds. In urban areas, four-way stops did constitute an appreciable interruption to arterial traffic streams. But on rural highways both the installation frequency index and the vehicular time interval spacing differ considerably from urban figures. To illustrate how little delay such installations cause, figures obtained by a study at the intersection of two State highways where the average total hourly traffic was 231 vehicles, showed that the average delay was 2.46 seconds for women drivers, 1.79 seconds for men drivers, 3.22 seconds for light trucks, and 2.48 seconds for heavy trucks. The maximum delay varied from 3.55 seconds for trucks to 5.10 seconds for women drivers.

With vehicles spaced 6 sec. apart, 600 can pass an intersection on one route in an hour; if the minor route has a percentage of 40, the total traffic passing the intersection is 840 vehicles per hour. In general it is considered that an interval of 6 sec. or less constitutes an access problem, and the continuous flow of traffic on the more important route must, therefore, be interrupted at strategic locations.



Interior of the new supercharged diesel power plant, 5,000-kw capacity, recently put into service at New Bern, N. C. The illustration shows the engines and generators.

Supercharged Diesels Supply Power for New Bern

THE opening of the new 5,000-kw municipally owned diesel electric power plant by the City of New Bern, N. C., recently completed at a cost of $600,000, marked the climax of the efforts of city officials to provide adequate electric service to the citizens of New Bern and surrounding area. This city of 20,000 inhabitants has owned and operated its own power plant for more than 40 years. It was among the first cities in the United States to own and operate an electric power plant.

In 1913 the city purchased its first power unit: a 400-kw engine type generator and engine. The intervening years have required the solution of many problems. In 1918, some 600 customers overloaded this unit and the problem was solved then by installing a 750-kw turbine-driven generator. In another six years the use of electric current had increased enough to require a new 1,250-kw turbine-driven unit. In 1928 a 2,500-kw turbine-driven generator was installed with the intention of handling the growth of the next 20 years. However, the population doubled between 1942 and 1947. The 750-kw unit was not being used, and the 1,250-kw unit was badly in need of major repairs. As a result the 2,500-kw unit was operated at full load and the balance of the city's electrical needs were purchased from the Tidewater Power Company.

Realizing that this was not a healthy condition, Burns and McDonnell, consulting engineers, Kansas City, Mo., were employed to survey the city's needs, including present and probable future needs, fuel costs, operation costs and the comparative advantages and limitations of steam and diesel power. As a result of this survey, three solutions were offered: (1) purchased power, (2) a new steam plant including the newest unit in the old plant moved into a new plant and new steam equipment to meet load requirements, and (3) a new diesel-electric plant having an output capacity of at least 3,600 kw and utilizing three to five units.

Solving the Problem

Comprehensive economic studies were then made of each of these solutions to determine relative merits and costs of each one. The result showed conclusively the advisability of a new diesel-electric plant and specifications were accordingly prepared calling for three to five units, with either supercharged or naturally aspirated engines. Later a contract was let for five Superior supercharged diesels, developing 1,000 kw each.

Although old estimates of the cost of electricity cannot be realized because of advances in the cost of fuel oil from 6.6 cents per gallon in 1945 to 10.2 cents per gallon, similar increases in the price of coal have occurred. A price of $10.05 per ton at the neighboring city of Kinston, N. C., compares with a prewar price of $5.25 per ton. At the old figure of fuel oil costs, the coming year's operating costs were estimated at $175,000. New fuel oil costs are expected to raise this figure about 40 per cent. This will raise the cost of producing current from an estimated 0.799 cent per kilowatt to 1.13 cents per kilowatt.

The New Plant

The total of 5,000 kw is generated by five 1,500 hp supercharged Model 80-GX-8 Superior diesels, each driving an Electric Machinery Mfg. Co. generator at 360 rpm. These engines are of the 4-cycle, cold starting, mechanical injection type, with eight cylinders of 14½-in. bore and 20-in. stroke, equipped with oil cooled pistons, Woodward hydraulic governor, duplex fuel oil filter, automatic alarm and emergency shut-down system, and many other features of the most modern type. The lubricating system is a force-feed, dry-sump type with a rotary pump unit, mounted at the control end of the engine and driven by silent roller chain from the crankshaft. Lubricating oil cooler is of the shell and tube type.

The power plant is housed in a new building of Colonial architecture, designed by Burns and McDonnell. In it, in addition to the engine room, are offices and a large basement in which are located the lubricating oil sump tanks, oil-reclaimers, compressors, air storage tanks and bank of storage batteries. The engine room is large enough to accommodate an additional diesel-electric power unit. The new plant will be operated by a staff of four engineers under W. B. Bartling, water and light superintendent. C. H. Helms is City Manager.

Construction of the new power plant also required an additional distribution system costing about $150,000. With additional lines the distribution system carries 70 per cent more current than before and voltage was stepped up from 2,400 to 4,160 volts. The city owns about 150 miles of electric lines. A total of 7,630 electric meters were in use on July 1, 1947, with 77 per cent of the accounts in the city and 23 per cent in rural areas. The preceding year's receipts totaled approximately $525,000 which was a gain of 17½ per cent over the previous year.

The city will also benefit from the new plant by supplying the power for pumping its water supply. Water is supplied from wells and is pumped into a new 300,000-gal. concrete reservoir on a high point near the city limits and an older metal tower standpipe near the power plant.

Low Cost WINTER SAFETY

THEODORE YOUNG
City Engineer, East Orange, N. J.

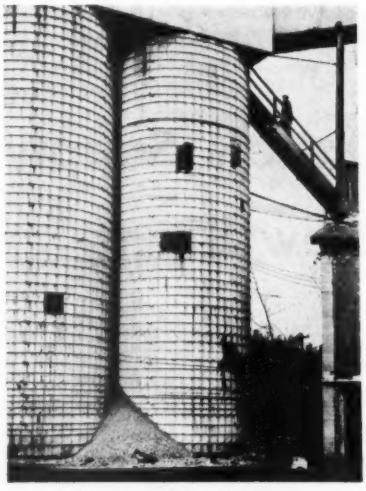
This article, based primarily on experiences in the winter of 1947-48, is intended to remind our readers that it is time now to think of and plan for winter and the ice and snow problems to come.

WINTER safety costs only .004 cent per square yard of street for every snow or ice storm in East Orange. Over the past several years we have worked out a snow and ice removal program that cuts cost to this bare minimum and at the same time keeps our streets so completely snow-free that newspapers in several surrounding towns point to our department as an example for their own to follow. We let rock salt do a large part of our snow and ice removal work, and, small as that .004-cent figure is, it includes not only the cost of the rock salt itself but the cost of the spreading equipment and its depreciation, and the labor involved in unloading, storing, reloading and spreading on the streets.

To keep that figure so low we have built up an organization that hits a snow or sleet storm before it hurts us and keeps after it until it is licked. By getting advance Weather Bureau reports, we are on the streets immediately snow or freezing rain starts to fall, spreading rock salt on every street in the city, covering main arteries from end to end, and treating every intersection and hill and the more heavily traveled sections of our secondary streets. We have 75 miles of streets in the city, 15 miles of which we completely covered with rock salt last winter; and 493 intersections which were similarly treated. In addition, on the hills we have 100 boxes of a rock salt-sand mixture and a shovel for the use of motorists who might get stuck before our men arrive there. We also shovel rock salt underneath parked cars if ice has formed there.

Two-Way Radio for the Snow Plow

Last winter we took several steps that have made our program even more efficient than it has been in the past. Now, we are going to equip one of the trucks used for snow plowing with a two-way radio, which permits contact with police headquarters. As a result, the plow can be sent instantly to help untangle traffic snarls or to clean streets for the passage of fire equipment or ambulances. Installation of the equipment will be paid for by economies already effected by the department.



Silos are used for salt storage.

In addition to that, we have purchased a special truck body for spreading rock salt. In the past we used five trucks with trailer spreaders, which were able to cover only about 15 miles of streets before they had to be taken off that work and attached to snow plows. Each truck required the services of a driver and two men. Now that we have the truck equipped with the special body we have found that it permits speedier application of rock salt, with the result that we can take care of more miles of streets, and only one man is required to operate it.

When the snowfall does not exceed three inches, we use rock salt without plowing and get bare pavement shortly after the storm stops. If the fall exceeds three inches, we plow. Because that system reduces plowing time throughout the winter, it saves us a great deal of money. And, in addition, it gives us snow- and ice-free streets, with no patches or thin films of snow. As a result, motorists have safe streets on which to drive, and skidding accidents are kept to a minimum.

Spread at the beginning of a storm rock salt helps to melt the snowfall, and, on those occasions when we have to plow, keeps it mealy and prevents its freezing to the street surface until we can do so. If snow has packed or ice has formed before we can get to it, the rock salt crystals break up the frozen mass and loosen the bond with the street so that it can be removed.

We began developing our snow removal technique during the 1936-37 winter, when we used rock salt experimentally. At that time we mixed it with cinders, but we have since discovered that rock salt alone will do a better, cleaner, and cheaper job. We never spread straight cinders or sand.

During the winter we store a supply of rock salt in a silo which we rent at nominal cost from the Multiplex Concrete Block Company. In the spring we clean it out and turn it back to the company, which requires its use then. It makes an excellent storage space for us because trucks can pull up to it for quick loading. We store an additional supply of rock salt in the city garage so that we are sure of having enough on hand for emergencies.

Procedure When Borough Buys Water Works

UNDER the Pennsylvania statutes, the proper and only procedure for a borough to acquire the plant and works of a water company is to apply first for a certificate of public convenience. The borough may then obtain the necessary information concerning the price to be offered for the water company's property under the commission's order for the examination of its books, etc. Womelsdorf Consol. Water Co. v. Pennsylvania Public Utility Commission, 160 Pa. Super. 298, 50 A. 2d 548.

PUBLIC WORKS DIGESTS

Sewerage

Water Supply

Highways and Airports

This section digests and briefs the important articles appearing in the periodicals that reached this office prior to the 15th of the previous month. Appended are Bibliographies of the principal articles, in which the articles in each periodical are numbered consecutively throughout the year, beginning with our January issue.

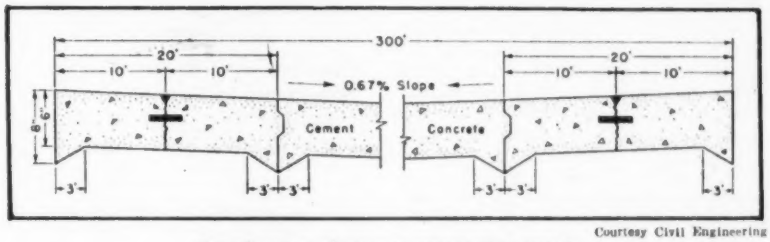
The letter and number at the end of each item refer to those used in the Bibliography. Numbers not found in the current Bibliography will be found in the one published the previous month.

The Highway and Airport Digest

Joints in Concrete Pavements

Observations made during a test of the value of bituminous subsealing of concrete pavement indicated certain conclusions concerning construction features that affected distress and failure of the pavement. Among these conclusions were the following: Drainage is of paramount importance. Features that might cause or encourage entrapment of moisture beneath the pavement should be meticulously avoided; among these being thickened slab edges along construction and expansion joints, and the valley-type drainage way through the center of the parking apron. Where these are considered necessary, subdrainage to permit escape of entrapped water should be provided. Subgrade pumping occurred almost invariably along construction joints. Tongue-and-groove keys in construction joints did not function properly as a load transfer device after the first general expansion and contraction cycle of the pavement. Dowel bars provide an efficient means for transferring loads across the joints and for retarding pavement distress. All dowel bars should be of deformed steel except in transverse expansion joints, where smooth round dowels are required. Airfield pavement should be of uniform thickness throughout, with all joints doweled except longitudinal expansion joints. The single exception to the uniform thickness rule is the outside edge of the outside tier of slabs, where additional strength is required owing to lack of inter-support, and where thickened slab edges do not present a drainage problem.

A plane of weakness should be provided in all joints to allow the pavement to adjust itself to a varying subgrade without unpatterned fracturing. All joints should be grooved and filled with sealing material. Grooves should be of greater cross section than has been the custom heretofore, because the life and elasticity of the sealing material is proportionately greater as its volume is increased.[L14]



Courtesy Civil Engineering

Typical section of concrete pavement as tested.

Compacting a Swamp Fill

The Philadelphia Southwest Airport is located on swamp land mostly covered by water at high tide. The soil to a depth of 25 to 30 ft. is silt, clay and organic materials containing high percentages of water, under which is sand and gravel. About 160 acres of this will be site of the apron and structures, and must be relatively unyielding. To stabilize it, the area is being covered with excellent sand and gravel, containing only a small amount of fines, to a depth of 10 to 16 ft., bringing it 2 to 5 ft. above design grade, which will be allowed to settle by squeezing the water out of the soil. To receive and remove this water a drainage ditch 12 ft. deep was dug around the area. All slopes of both cut and fill were made 10:1 to 40:1 to avoid causing mud waves. The fill material was spread in 12" layers, each compacted separately with track tractors weighing at least 17 tons, each part of the area to be passed over at least six times by a track. The tractors operated at about 2.7 mph. Heavy tractors were preferred to sheepsfoot or other rollers because of the vibration caused by these machines—much greater than that produced by a loaded hauling truck weighing 34 tons gross. Hauling and spreading compacted the fill to 95% modified AASHO 2 ft. below the surface, and the six passes of the tractor increased this to 110 to 115%. Before the fill started, steel plates 3 ft. square were placed on the original surface, to each of which plates was welded a vertical pipe to serve as a gauge of settlement. One of these gauges, where a 16 ft. fill was completed in November, 1947, showed settlement of about an inch a week during October and November, but by March, 1948, the settlement had decreased to about ¼ in. per week. As the fill rose the water table rose also and today is only 1 to 2 ft. below the highest portion of the fill.[E13]

Bituminous Subsealing of Concrete Pavements

To test the merits of subsealing concrete pavements with asphalt, the Air Installation Division of the U.S. Air Force conducted an accelerated traffic test on an oval test track ¼ mile long, one half of which was subsealed and the other half not. This pavement was part of a parking apron which had showed indications of imminent distress. The pavement is 8-6-6-8 thick, tapering in 3 ft. widths. A test vehicle traveled

around the track at 10 mph for 16 hr. a day, seven days a week, for a total of 15,335 cycles, the weight being increased at intervals from an initial 30,000 lb. to a final 60,000 lb. The test was concluded because further travel over the untreated portion was impossible because of total failure of 87½% of the slabs and fracture of all others. In the subsealed portion, only 12½% of the slabs had failed and 24½ were unfractured.

The test substantiated the merits of bituminous subsealing as a preventive maintenance measure if applied before excessive fracturing has developed. It fills voids or cavities that have been caused by traffic consolidation of the subgrade or otherwise, thus reestablishing uniform support of the slabs at all points. It places a watertight membrane between pavement and subgrade, preventing infiltration of surface water and under-pavement seepage. It prevents absorption of moisture into the concrete, thereby greatly reducing the cycle of expansion-contraction.[L14]

Using Draglines

An English consulting engineer gives in this article excellent practical advice on the use of the dragline, which, he says, "in recent years has become our most generally useful and deservedly popular excavator. . . . Boom lengths can be altered and suitable sizes, types and weights of buckets fitted on any size of machine to suit the material and working conditions on any job." But if too large a bucket is used or too long a working radius there will be increased wear and maintenance or even breakages. British makers, in stating capacity, use a stability factor of 66 2/3%, but American makers other than Bucyrue-Erie and Marion (and possibly others) use 75%. Also, British machines are about 1/3 heavier than American. Most of the dragline buckets he names are American types—Bucyrus, Page, Esco, Yaun, Hendrix and Ransome.

Among hints for operating, he says: Do not throw the bucket into the bottom of the cut beyond the boom-head radius—75% of bucket repairs are caused by this. Dig in horizontal layers as far as practicable, and avoid building up windrows in front of the machine. Pick up the bucket as soon as it is full, do not drag it. Keep drag and hoist brakes accurately adjusted. Keep bucket teeth sharp. Turning the drag and hoist ropes end for end about half-way through their working life will increase it. Do not use the boom at a flatter angle than 25° with the horizontal, and 30° to 35° is preferable; the flatter the angle, the greater the hoisting and swaying stresses on the boom.[Y5]

An English Experimental Concrete Road

A stretch of experimental road at Oxton, Nottinghamshire, England, 3600 ft. long is being laid with the aid of determining the least thickness of concrete pavement that will be adequate for a certain volume and weight of traffic on different kinds of soil. The thicknesses used range from far thinner than any normal calculation would give (some of which are expected to fail) to very thick ones. Also different sections were laid on soils treated in different ways to increase their bearing power, as by soil-cement of different mixtures and thicknesses.[Y6]

Controlling Snow Drifting

In studying this subject, the author conceived the idea of simulating the effect on snow drifting of a row of trees by placing tar barrels in a row. In February, 1948, when a snow warning was received, two men placed barrels along a line 750 ft. long in less than an hour. This caused drifts to form in the lee of the barrels for a length of 10 or 12 ft. with a clear zone beyond. A spacing of a barrel for each 6 ft. seemed to give the best results. The advantages of barrels are that they are cheap and can be moved quickly to any desired position, and can be removed entirely in summer.[D19]

Concrete Pavements in Germany

During the summer of 1947 two engineers of the Public Roads Administration inspected concrete pavements on the German "Autobahnen" to determine in what respects, if any, the German pavements are superior to ours and what features of design or construction could profitably be adopted in American practices. The survey covered about 1,000 miles of 4-lane divided pavement. All of the structural defects that usually develop in concrete pavements in the United States were found but, aside from frequently observed transverse cracking, defects such as joint spalling and faulting, settlement, etc., were not serious except in the Frankfurt area. The comparative freedom of the German roads from structural defects is believed to be due primarily to the comparatively small amount of heavy truck traffic using these roads, now and in the past, and to the comparatively mild climate.

The soils of Germany vary from cohesionless sands to plastic silty clays and clays. Most of the silty clays were of such nature as to require careful moisture control for adequate compaction. Such soils would be subject to frost heave under adverse drainage conditions, and pumping at joints would occur on them if free water entered expansion joints or cracks and if a sufficient number of heavy loads passed over the pavement. The practice of placing a layer of granular material under the pavement was, no doubt, a contributing factor in the prevention of pumping in such cases.

The concrete, almost without exception, was of excellent quality. Scaling was confined almost entirely to the Munchen-Salzburg route. Disintegration was practically nonexistent. Outstanding was the absence of the heavy layer of surface mortar frequently found on pavements in the United States. The excellent quality of the concrete is believed due to (1) the high quality of aggregates, (2) the low water-cement ratio, (3) thorough consolidation by tamping and vibration of a very dry mixture with a maximum aggregate size of about 1 inch, (4) thorough curing, and (5) the comparatively mild climate. The effect of the cement is not clear—German cements were definitely inferior as judged by modern American standards, but whether they were actually inferior remains to be seen.

As a result of their observations the authors recommend the initiation of a comprehensive program of research on each of the following subjects:

1. Study of the possibility of insuring greater uniformity in pavement concrete by reducing the maximum size of coarse aggregate.

2. Development of more effective methods of compacting pavement concrete by mechanical means.

3. Study of the effects of variations in chemical composition of cements and the methods of manufacturing cements on the properties of concrete.[U7]

Stabilized Turf Shoulders

Shoulders, to be practical, must be either aggregate or turf. Turf shoulders are far cheaper to maintain than aggregate. With the latter there is constant expense for dragging, blading, adding material and rolling. Several states have proved that it is possible to have a stabilized shoulder covered with vegetation and cheaply maintained. Given a shoulder built with crusher-run broken stone or gravel that passes a 1" screen, to grow grass on this requires proper pH, sufficient plant nutrients and water. Much of this is supplied by the addition of 5% to 10% of soil to the aggregates, which will retain moisture and applied fertilizers. The fertilizers should be mixed throughout the soil and aggregate. A slight layer of top soil aids in seed germination but is not essential. The maintenance of such shoulders consists of "spaced" mowings, rolling, sweeping and occasional light "scalping" in the early spring, and repairs to mend minor damage. Shoulders not stable enough to handle the known traffic should not be camouflaged with grass.[N46]

Soil-Cement Ditch Lining

In District 10 of the Texas highway department, roadside ditches are lined with soil-cement instead of sod. The ditches are cut 4" below finished grade, with the same pitch as the adjoining slopes. The soil-cement is mixed in a 14 cu. ft. pugmill, the soil used being fine sand, and 2 bags of cement being

used per cu. yd. of sand. The mixture is spread 4" deep with hoes and surfaced with wooden floats followed by trowels. Near intersections the soil-cement is laid 6" thick and 3 bags of cement per cu. yd. used. The cost averaged 45c per sq. yd.[N49]

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19. Observations on Snowdrift Formation and Methods of Control. By G. H. Bates. Pp. 247-248.

May 28

20. Economical Methods of Highway Repairs to Meet Present Day Needs. By Douglas Bailey. Pp. 271-272.

E *Engineering News-Record*

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12. Dual-Lane Bypass Road at Norfolk Incorporates Triple-Level Bridge. Pp. 68-69.

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13. Heavy Tractors Compact Swamp Fill for Airport Enlargement. By C. C. Munoz. Pp. 86-87.
14. Virginia Reconstructs U. S. Route 60 as Dual-Lane Divided Highway. Pp. 100-101.

J *American City*

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8. Emulsified Asphalt's Record as a Base Stabilizer. Pp. 120-121.

L *Civil Engineering*

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13. Accelerated Highway Program Calls for New Design and Construction Techniques. By Day Okes. Pp. 22-27.
14. Bituminous Subsealed Concrete Pavements Withstand Accelerated Traffic Tests. Pp. 40-43.

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47. Runway Snow Plowing Plan Paid Off at La Guardia Airport. Pp. 62-64.
48. Face-Lifting Milwaukee's Wisconsin Ave. Pp. 65-66.
49. Soil-Cement Ditch Lining. P. 67.
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25. Merits of Roadmixing Machines for Asphalt Pavements. By John M. Greene. Pp. 75, 111.

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22. Jacked-in-Place Drainage Pipe. By Jacob Feld. P. 31.
23. Stabilized Turf Shoulders for Parkways. By Oliver A. Deakin. P. 31.
24. Salvaging Old Pavements in Ohio. By C. R. Hanes. Pp. 31-32.
25. Flow Through Gutter Inlet Gratings. By Curtis L. Larson. P. 32.
26. Continuously Reinforced Concrete Pavements. P. 32.
27. Design Data on Foreign Airports. P. 37.

U *Public Roads*

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7. Concrete Pavements on the German Autobahnen. By F. H. Jackson and Harold Allen. Pp. 65-79.
8. Analysis of Rectangular Reinforced Concrete Sections to Direct Stress and Bending in Two Directions. By David M. Goodall. Pp. 80-83.

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May 5

5. Draglines, Buckets and Ratings. By W. Barnes. Pp. 11-19, 26.
6. Experimental Concrete Roads. Pp. 27-28.

Relocating Water Pipe Lines in Highways

THE mere fear on the part of the officers of a water works company that the Department of Highways may take such action in improving the highways as may necessitate the removal or relocation of pipe lines laid by the water works company along a specified road, is not such an "actual controversy" as will entitle the company to a declaratory judgment as to the liability of the water works company, as holder of the easement in the highway, to bear the expense of relocating its pipe line. Commonwealth v. Winchester Water Works, Kentucky Court of Appeals, 197 S. W. 2d 771.

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The Sewerage Digest

Effect of Temperature on B.O.D.

From the experiments described in this article it was concluded that the general course of the first stage of biochemical oxidation of diluted sewage conforms closely to Phelps unimolecular equation. The magnitudes of the rate for domestic sewage are larger than the usually accepted values in the temperature range of 5° to 30° C—twice such value at 20°; but the magnitudes for different sewages at any given temperature may vary considerably, and this and the lag make the 5-day BOD not very reliable as a measure of the strength of sewage and wastes. The relationship between the oxidation rate and the temperature varies as some constant power of the latter for each of two temperature ranges—5° to 30° C and above 30°C. The magnitudes of the ultimate first stage of biochemical oxidation of sewage are not affected significantly by the temperature of incubation between 5° and 30°. At and above 30° there may be considerable nitrification taking place during the apparent first stage of oxidation, which may make the BOD larger than at lower temperatures. Below 15° C the lag period increases as the temperature falls; at 20° and above, temperature has little effect on the lag period. The second (nitrification) stage is much more erratic than the first, its relation to temperature is not so consistent, and the time of its onset is retarded as the temperature falls below 20°, being possibly 60 to 70 days at 5° C.[C33]

Digester Capacity

Calculating digester size on the basis of cubic feet per capita has proved generally satisfactory for a small plant treating solely domestic sewage; but where the sewage contains considerable quantities of industrial wastes this method, using a factor of equivalent population, has not proved adequate. To develop a more reliable method, the author studied the records of nearly 50 digester installations. Nearly 30 of these lacked some basic information, and 14 were finally selected as furnishing fairly complete and reliable data. These included 6 treating primary sedimentation sludge, 3 primary and activated, 2 imhoff tank, one trickling filter and one chemical precipatation. These digesters had detention periods varying from 11 to 72 days; the volatile matter in the raw sludge varied from 63.0% to 86.3% and the solids content from 4.5% to 9.4%. He assumed the weight of sludge as 65 lb. per cu. ft., and that the gas produced was equivalent to 14.5 cu. ft. per pound of volatile matter. He found that plants having detention periods of less than 30 days experienced supernatant troubles while those of 60 days or over did not. Experiences seemed to indicate that the best place to thicken sludge was ahead of the digesters—preferably in the primary sedimentation tanks.

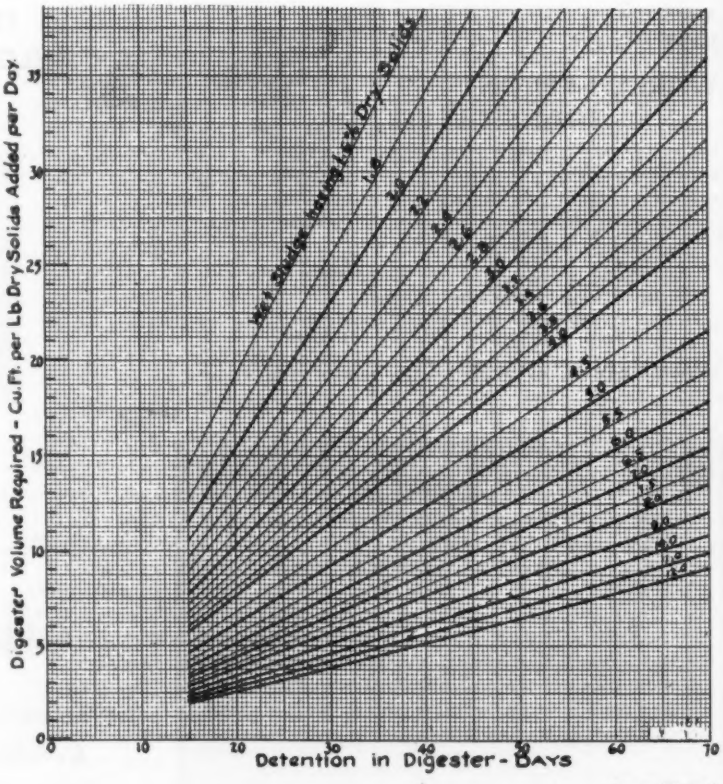
From this study he concluded that the dry solids method of computing digester loading and performance is not sound; that the volume of raw sludge feed and its detention in the digester seems to bear a close relation to volatile matter reduction, regardless of the type of sludge. He therefore proposes a raw sludge detention method of evaluating digester performance and of calculating desired volume.[C34]

Hydrogen Sulfide in Sewage

For sulfate reduction to take place in sewage, organic matter must be present, oxygen or nitrates must be absent, sulfates must be present, and temperature must be favorable. The reduction takes place under the influence of a group of organisms, the number of which in sewage is restricted. When sewage is stored in the laboratory, the number of these organisms does not increase immediately but remains at the initial low level for about a week. Investigation indicated that this lag is predicated on the activity of non-sulfate-reducing organisms in lowering the oxidation-reduction potential to a level favorable to sulfate-reducing organisms, after which the production of sulfide further lowers the potential.

Other indications by the tests were that the number of sulfate-reducing organisms in sewage is low, but is greater in sludges. Chlorine dosage at 60% of the demand destroys them. There is good correlation between the number of them and the rate of sulfide production in stored sewage; both show a definite initial lag which is considerably shortened by the addition of a culture of *Sporovibrio desulfuricans*. The rate of production is increased by the addition of sulfide to sewage but not by adding sodium lactate. The lag in sulfide production in stored sewage and the failure of sulfide production in the flowing body of sewage in sewers are caused by the unfavorable oxidation-reduction potential.

From the above it was concluded



Sewage Works Journal

Digester volume-detention period relationships.

that in sewers the detention time of the flowing portion of the sewage is not long enough to bring about a sufficiently low oxidation-reduction potential, with the result that the organisms do not multiply and hydrogen sulfide is not produced. In the sludge deposits the oxidation-reduction potential is low, a large number of organisms are found, and the resultant rate of activity is high under favorable temperature conditions. The function of the flowing portion of the sewage is to furnish a continuous supply of sulfates, which after reduction in the sludge are diffused back to the sewage.[C36]

A Milk-Waste Treatment Plant

A milk factory at Ovid, Mich., with a milk input of 150,000 to 500,000 lb. per day, processes 50,000 to 450,000 and discharges the wastes into a river whose summer flow often falls to 5 cfs for extended periods of time. This caused nuisances and destruction of fish for 6 miles below the outlet and it was determined by a stream survey that proper stream protection would require the pollution load to be reduced to 40 lb. per day of B.O.D. Vacuum pan water contributed 10 lb. per day and the company elected to discharge this untreated and to so treat the remaining wastes as to produce an effluent limited to 30 lb. of B.O.D. per day. The process selected to accomplish this consists of biological filtration in two stages with recirculation and high rates of application. The plant, which went into operation last October, consists of a bar screen, pumps with controls for recirculation, primary and secondary clarifiers, primary and secondary filters, and an unheated sludge digestion tank.[C38]

Unheated Sludge Digesters

Unheated sludge digesters have a field of usefulness for small communities and institutions, including the following: Gravity transfer of raw sludge from hopper-bottom plain settling tanks. Elevated open-top units to which raw sludge is pumped from settling tanks. Open-top or covered units used as secondary units following primary digestion of raw solids. The unheated digester is a competitor of the Imhoff tank in the 1500 to 5,000 connected population range. Below this the writer prefers septic tanks; above it, gas utilization with heated digesters becomes a factor. Open unheated digesters present no explosion hazard and very little fire hazard.[G19]

Well Points for Trench Dewatering

In laying 12,750 ft. of sewer in Los Angeles, Calif., in wet sand and sandy loam, where the ground water was well above the sewer invert and in places standing above the surface, dewatering by well points permitted excavating and laying of sewer in a dry trench, the trench being held dewatered for three days after backfilling. The cost of all labor and materials, equipment rental and all other charges for the well point system was $12,595, or about $1 a foot. Progress in pipe laying varied from 50 to 200 ft. per day. As a general thing the well points were spaced at 2 ft. intervals along one side of the trench, extending 5 to 8 ft. below trench bottom. The equipment included 1500 ft. of 8" spiral welded steel pipe with 2" outlets at 2 ft. intervals; 3 suction pumps; one jet pump; one 6" jet pipe; about 700 well points.[G20]

New Method of Heating Digestion Tanks

Following test operations, a new method of sludge heating is being installed at the Northeast Treatment Works of Philadelphia, Pa. The cold sludge, together with supernatant, is pumped from storage tanks to the desired number of heater tanks (6 tanks are provided) and from these to the digesters. The number of heaters in use at any time is controlled to give the sludge in the digestion tanks any desired temperature. In each heating tank is a burner with a capacity of 3850 cu. ft. of digester gas per hour, which projects downward into the sludge. Digester gas pre-mixed with air enters a combustion chamber under pressure, where temperatures as high as 2,400° F are reached and the combustion gases (but not flame) are discharged into the surrounding sludge at

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speeds up to 30 fps, give up their heat and are expelled at 150° to 180°. The gases from the combustion chamber keep the sludge stirred up, heating all of that in the tank and preventing sedimentation. This method was developed by cooperation of the city's engineers and the Selas Corp.[G21]

Fodder Yeast From Sulfite Waste

Investigators in charge of research into methods of disposing of sulfite waste liquor have developed a "yeast propagator" which produces about 8.7 grams of yeast per liter of sulfite waste liquor containing 30.4 grams per liter of reducing substances. This yeast contains approximately 50% protein, which would make it acceptable as a source of nitrogen for the preparation of stock feed, and also contains vitamins of the B complex. It was estimated that it could be made for 3c per pound, of which cost 21.0% would be capital cost, 32.3% labor, 29.9% propagator operation and 16.8% marketing cost.

For two years sulfite liquors had been treated by these investigators on high-rate trickling filters and several types of yeast developed at pH 3. The yeast propagator developed by them substitutes foam for crushed stone as a filter medium. A 4" vertical tube 16 ft. high served as a filter. Air forced into the liquor in the bottom of this tube in the foam of bubbles produced a foam which rose to the top of the tube and overflowed; the relative rates of application of air and liquor being such as to keep the foam 13 ft. high and the liquor about 2 ft. The liquor, including that recycled from the bottom of the tube, was applied at the top and traveled down as the air bubbles rose. The bubbles give a much greater surface of contact between air and liquor than does a stone filter, thus greatly increasing the oxidation effectiveness. Also there is no trouble due to clogging. Recirculation provides an increased time of contact between the organisms and the air in the foam; about 20 recirculations were found advisable. The foam also is recirculated. The yeast must not be withdrawn at a rate greater than its growth rate so that the yeast population in the unit will not be depleted. The yeast is separated from the foam that is drawn off by centrifuging.[C39]

Treating Carbonaceous Wastes

Carbonaceous wastes can be treated by conventional sewage treatment methods, but these methods may be costly. The minimum treatment given food-processing wastes should be screening, with the size of openings determined by the type of waste and the subsequent treatment or disposal. Vacuum flotation removes a high percentage of suspended solids from fruit wastes with short detention times. Trickling filters are more satisfactory than the activated sludge process for the treatment of carbohydrate wastes. Predigestion of high B.O.D. wastes offers an economical method of pretreatment. There is need for more pilot plant studies to reduce costs of industrial waste treatment.[C41]

Refuse Disposal Practice

Data were collected from 300 cities, and some of the results were summarized as follows: Collection is by municipal forces in 164 cities, by private collectors in 26, and by private arrangement of home owners in 37. Disposal is by hog feeding in 41% of the cities reporting; by dumps in 37%; by incineration in 28% (with almost as many expecting to change to this); and sanitary fill in 25%. Costs of refuse collection and disposal vary widely, from 17 cts per capita per year to $5.03. The cost seems to bear little relation to the size of the city; the median costs for all population classes of cities, (250,000-500,000, 100,000-250,000, 50,000-100,000, and 25,000-50,000) vary only from $1.23 to $1.80.[E17]

Alkalinity Control Of Trickling Filters

The treatment plant at Virginia Beach, Va., receives a sewage flow that varies from 0.3 mgd in winter to 1.25

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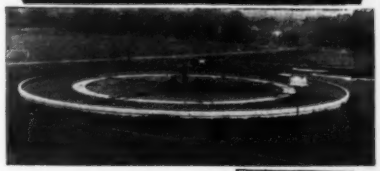

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mgd in summer, exclusive of infiltration. It contains two primary clarifiers, a secondary clarifier, trickling filter and final clarifier, 2-stage digesters and drying beds. The filter was designed for winter flow, and chemical treatment without filtration was to be used in summer. When the plant became inadequate for the high summer flows, chemical treatment and filtration both were used, lime being used as a coagulant. Various experiments were tried to find the optimum pH and alkalinity to produce the best filter growth and effluent. The answer was found to be the conversion of bicarbonate alkalinity to carbonate alkalinity. After primary treatment, sufficient calcium hydroxide is added to the settled sewage to produce carbonate alkalinity. Prechlorination is very important to prevent odors and poor sedimentation and the growth of unfavorable organisms on the filter.[C16]

Amperometric Titration of Chlorine

Chlorinated sewage apparently contains chlorine compounds which are not included to any great extent in the values obtained by the usual methods of determining residual chlorine. This fraction of the residual is included in the result obtained using *p*-aminodimethyl aniline with iodide or more consistently by using the amperometric titration procedure described in this paper. This fraction should not be neglected since it does exert considerable action against micro-organisms. A means of measuring this residual should be particularly important wherever it is desired to chlorinate to satisfy only a fraction of the usual demand, such as for the prevention of septicity(10). For this and similar purposes this convenient method of control by determining residual chlorine amperometrically, may make it feasible to obtain a desired result with chlorination rates that are more economically feasible.[G22]

Individual Disposal System

The U. S. Public Health Service, in conjunction with the Housing and Home Finance Agency, is investigating the subject of individual sewage disposal systems by studying the literature and the operation of existing systems, by constructing and operating septic tanks and subsurface drainage, studying effect of ground garbage and of grease on septic tank operation, and various other details of construction and operation of septic tanks and subsurface disposal. In this connection 8 experimental laboratory tanks and 12 full-size tanks are in operation at the Cincinnati investigation station; one a 2,000 gal. rectangular unit, the other eleven 500-gal. tanks, both cylindrical and rectangular, horizontal and vertical, with one, two, three and four compartments. Each tank is dosed 8 times daily with sewage from a residential area. In the laboratory, investigations include the effect of salts from home softeners, aspects of tank seeding, clogging in sand columns. To study ground absorption, subsurface drains have been laid with various grades, width, joint spacing and trench cover.[E19]

Chlorine Used During Septicization

Production of hydrogen sulfide and its odors are prevented by chlorine even in doses as low as 20 to 25% of the demand.

The elimination of hydrogen sulfide odors of sewage after they have been produced by septic action required nearly 10 times as much chlorine as the addition of chlorine to prevent their formation. The reason for this is that 75 per cent of the demand has to be satisfied to eliminate the hydrogen sulfide as compared with the 25 per cent required to prevent its formation. In addition, the chlorine demand increases in septic sewage by virtue of the increases in hydrogen sulfide and the increase in other substances which react with the chlorine. The dosage of chlorine required to combine with sulfides is only one quarter of the total demand.[G23]

Recording Instruments in Sewers

In operating the West Middlesex (England) main drainage system, information concerning the flow is obtained continuously by means of 52 standing-wave flume gauges and 30 level recorders. The former make weekly continuous records of flow in cu. ft.

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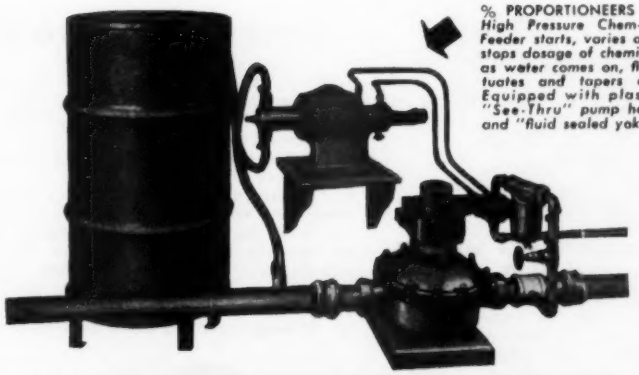

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per sec., and the latter monthly records of depths of flow. The flume recording mechanisms are mounted in cast-iron boxes above ground, and have suffered negligible deterioration in 6 or 7 years. Level recorders are housed in aluminum alloy boxes in manholes and corrosion of the casing and of the clock mechanism is rapid. The copper wires used in the instruments failed in a few months, but monel metal and stainless steel wires that replaced them have been entirely satisfactory.

As a result of experience at West Middlesex the following points as to recording instruments used in sewers in general have evolved:—

1. No instrument, especially those using a clock mechanism, should be placed in a manhole or anywhere exposed to sewer atmosphere.

2. The use of aluminum or aluminum alloys in instruments or connected gear should be avoided.

3. All brass used in instruments should be lacquered or otherwise protected by a coat of shellac.

4. Operating wires should be of monel metal or stainless steel.

5. All operating wires should be cleaned and re-greased at frequent intervals according to the amount of corrosion experienced.

6. Floats used in sewers should not be made of copper or china.

As a general principle it has been found that the answer to efficient recording from all instruments used in sewers is constant care and regular maintenance.[D24]

Sanitary Fill At Winnetka, Ill.

Winnetka has, for a year, been disposing of the mixed refuse of all kinds from 13,000 population on about 70 acres of marsh by sanitary fill. A trench about 4 ft. deep by 10 ft. wide is dug along the toe of the previous fill. This trench is filled with refuse and the deposit continued to 4 ft. above the original grade in 10 ft. layers, each thoroughly compacted by running a crawler tractor over it repeatedly. Sides and ends are covered each day with at least 6" of dirt, and the top covered with 2 ft. of dirt obtained by digging new trench. The equipment used is a drag-line with ½ yd. bucket and 30 ft. boom, used for excavating trench, and a tractor equipped with a Bull-clam. One man operates both. Extra labor is used occasionally for road work and other jobs. In February frost 3 ft. deep necessitated the use of air tools. A portable wire fence placed on the leeward side of the dump caught blowing papers. The greatest difficulty was with access to the dumping point for the collection trucks. It is proposed to use portable mats of the pierced-steel plank type, when obtainable. At present they are using heavy plank mats over the new fill; or dumping some distance back from the face and moving the material to the face with the Bull-clam.

During the year's operation 1.32 acres was covered to an average height of 3.74 ft. above the original grade. The 38,770 cu. yd. of material deposited compacted to 7,965 cu. yd. This amount of compaction was not anticipated and in the future the fill will be made 5½ ft. high instead of 3.74 ft. The cost per ton was 53.9 ct. for labor, 14.9 ct. for equipment plus 13.7 ct. depreciation, and 3.2 ct. for materials and supplies; a total of 85.7 ct. Some of this expense will not be incurred in the future, and future total cost is estimated at 73 ct. per ton. Cost in previous years using the open dump method varied from 47 to 52 ct., but the hauls were so much longer as to offset the apparently greater cost of the sanitary fill. Rodents are entirely absent, flies practically so, and there has been no trouble from odors or fire.[P21]

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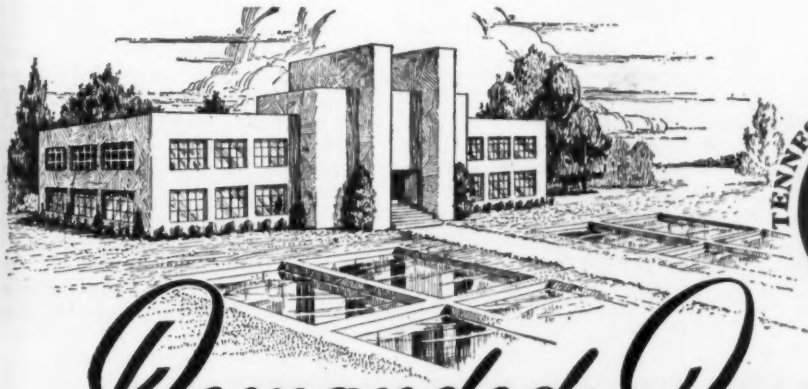
Extension of Water and Sewerage Lines Beyond City Limits

WHERE the charter of a city expressly provides for the extension of its public services, including those of water and sewerage, to those living beyond the city limits and for the acquisition of the facilities, including pipe lines, used for that purpose, the city may condemn therefor lands required either under the city charter or the general statute relating to the power of municipalities. City of Charlotte v. Heath, 226 N. C. 750, 40 N. E. 2d 600.



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How Cities Charge for Private Fire Protection Services

This concludes the data initiated in our May issue and continued in June.

East North Central

Illinois.— Blue Island, Allen L. Fox, City Engr., makes standard charges depending on the volume of water used. Lockport, Chas. F. Enz, Supt., reports a metered charge on elevated tanks only. Quincy, W. R. Gelston, Supt. Water Works Commission, charges as follows: 2″ connection, $25 per year; 4″, $50; 6″ $100; 8″, $150; 10″, $300. Robinson, William T. Schneider, Cons. Engr., charges 5¢ per head, and $500 minimum for a 6″ connection. No charge is made by Casey, De Kalb, De Pue, Downers Grove, Elmhurst, Hinsdale, Johnson City, Kewanee, Maywood, Monmouth, Morris, Olney, Princeton, Riverside, Rochelle, Springfield, Steger, Waukegan or Western Springs.

Indiana. — Berne, Paul M. Herman, Supt., Water Works, charges $2 a month for a 3″ connection; $4 for a 4″ and $3.50 for a 6″. Michigan City, H. J. Draves, Supt., charges $1 per circular inch of opening. In Mishawaka, A. R. Klein, Supt., the charge depends on the size of the connection. Rochester, Jack Gordon, Supt. of Water Dept., charges a flat rate of $25. Decatur, Greencastle, Jasonville and Muncie do not charge for such service.

Michigan. — Coldwater, L. E. McQueen, Supt., Bd. of Public Works, bases the charges on the size of the supply connection — $4 per month for a 4″, $6 for a 6″ and $8 for an 8″. Grand Rapids, M. M. Moore, Asst. City Engr., charges as follows: 4″ to 6″ connections, $50 per year; 8″, $90; 10″, $125, and 12″, $200. Kalamazoo, Earl E. Norman, Mgr. of City Light & Water Utilities, vary the charges with the size of the meter; the minimum charge, when no water is used, is $7 per quarter for a 4″ connection, $8.50 for a 6″ and $11 for an 8″. Manistee, Ernest L. Neumann, City Manager, charges a flat rate based on the size of service. Wayne, Raymond H. Wardwell, Supt. of Public Works, charges on size, as follows: 4″ and smaller, $2 per month; 6″, $4; 8″, $6; 10″, $8, and 12″ or larger, $10 per month. No charge is made by Alpena, Bluefield, Cheboygan, Iron Mountain, Jackson, Lapeer, Lansing, Marquette, Marshall City, Plymouth, Traverse City and Zeeland.

Ohio.—In Akron, W. R. La Due, Supt. and Chief Engr., rates are based on the size of the service connection or meter; a 6″ line with meter, $6 per quarter, and an unmetered line, $21. Chillicothe, A. S. Hibbs, Mgr., Municipal Water Works Dept., report a charge of 12¢ per head per year. Cleveland, G. H. Hamlin, Commr. of Water & Heat, charge $20 yearly for each fire service connection if unmetered. Cleveland Heights, Wiley C. Davis, Building & Water Commr., makes a yearly charge of $25. Cuyahoga Falls, L. F. Cook, Supt., report charges as follows for unmetered fire services: 2″, $8 per quarter; 3″, $12; 4″, $16; 6″, $24; and 8″, $40. Lakewood, Harlan F. Bartels, City Engineer, charges $5 per quarter. Massillon, A. A. Ulrich, Mgr., Ohio Water Service Co., charges on the floor space covered by the sprinkler system—2″ connection, 5000 sq. ft. or less, $3.40 per month; 4″, 10,000 sq. ft. or less, $5.70; 6″, 20,000 sq. ft. or less, $8.50. Napoleon, C. F. Kelly, Supt., reports the charge varies with the size of the line. Toledo, Geo. J. Van Dorp., Commr. of Water, states the yearly charge is based on the size of the service connection—4″, $8; 6″, $10; 8″, $15; 10″, $20; 12″, $25. Alliance, Barnesville, Canton, Celina, Elyria, Lancaster, Marietta, Mechanicsburg, Miamisburg, Middletown, New Philadelphia, Niles, Springfield, Troy, Wadsworth, Wooster and Xenia make no charge.

Wisconsin.—Antigo, H. A. Ehlers, Supt., Water and Sewage, report annual rates as follows: 2″ connections, $25; 3″, $50; 4″, $75; 6″, $100; 8″, $150. Baraboo, Leland Shaw, Supt. of Water Works, bases the charge on the size of the service to the fire hydrant—4″ connection, $6.25 per quarter; 6″, $12.50; and 8″, $18.75. Elkhorn, Basil Miller, Supt., charges $15 per quarter for a 4″ meter, and $25 for a 6″ meter. In Menasha, P. E. Widsteen, Supt., the quarterly rate depends on the size of the meter, as follows: 4″, $25; 6″, $30; 8″, $50; 10″, $65, and 12″, $75. Racine, W. A. Peirce, Mgr., Water Dept., charges $50 per year for 1,667 heads, and 3¢ per head above this number. Sheboygan, Jerome C. Zufelt, makes a charge of $22.50 per year for each private fire hydrant. Stevens Point, Verne A. Somers, Supt., Water & Sewage Utilities, state the charge is based on the size of the water line serving the building and by the number of square feet of floor space under protection. Stoughton, C. A. Dahle, Supt., bases the charge on the size of the service pipe—4″, $20 per quarter; 6″, $35; and 8″, $55. Whitewater, E. M. Drewry, Supt., charges $6.50 quarterly. Wisconsin Rapids, Frank L. Steib, Gen. Mgr., reports the quarterly charge is based on the size of the connection, as follows: 2″, $18.75; 2½″, $22.50; 3″, $26; 4″, $37.50; 6″, $60; 8″, $90. The cities of Appleton, Mayville, New London, New Richmond, Reedsburg, Rhinelander and South Milwaukee report that no charge is made for such service.

South Atlantic

Georgia. — Athens, J. G. Beacham, City Engr. & Supt. of Water Works, charges $20 per year for each fire hydrant and $40 for each sprinkler connection. Atlanta, Paul Weir, Gen. Mgr., Atlanta Water Works, charges for the full cost of installation and $3.50 per month for a 6″ tap. Augusta, M. B. Cooper, Supt., Canal & Water Works, charges cost plus 15% for connections. Griffin makes no charge. Macon, T. E. P. Woodward, Supt., makes no charge other than for connections; the owner is required to pay for the tap at the main and for the cost of running the service pipe to the building line.

North Carolina.—Kings Mountain, L. C. Parsons, Supt. of Public Works, makes a charge of $1.00 per month. No charge is made by Albemarle, Elizabeth City and Hartford.

Virginia. — Roanoke, Chas. E. Moore, Mgr., reports the following charges: Minimum per month, 4″ connection, $3; 6″, $3.75; 8″, $5. No charge is made by Bristol, Danville, Harrisonburg, Norton, Petersburg, Portsmouth, Richmond, Waynesboro and Winchester.

West Virginia. — Hinton, A. G. Timberlake, Supt., W. Va., Water Service Co., reports a monthly charge based on the size of the connection—2″, $2; 3″, $2.40; 4″, $3.20; 6″, $7.20; 8″, $12.80 (less 5% for prompt payment). Wheeling, Jay E. Henry, City Engr., charges $25 yearly for a 4″, $50 for a 6″ and $90 for an 8″. No charge is made by Grafton, Paden City and Williamson.

The Water Works Digest

Diatomaceous Earth Filters

This type of filter may be of special value in clarifying surface water from lakes and large reservoirs where high turbidities do not prevail but where algae and suspended solids may be removed without elaborate flocculating and clarifying equipment.

The amount of diatomaceous earth required as a "precoat" for this purpose is 5-10 lb. per 100 sq. ft. of effective filter (strainer) area. Additional filter aid, in amounts of 12-42 ppm., is necessary to maintain effective porosity of the material, depending upon the suspended solid content of the raw water. With waters of high color and turbidity, a coagulant is needed in addition.

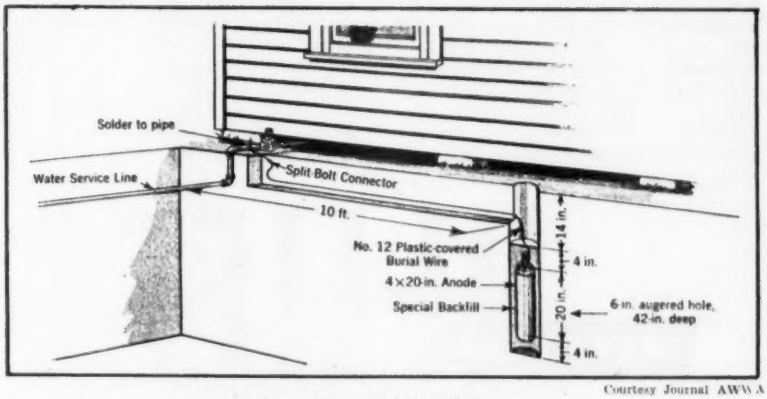
The loss of head through such units varies in the range of 15 to approximately 35 psi., which is considerably greater than with conventional sand filters. Here again the relationship among rates of filtration, loss of head and length of filter runs controls the economy of treatment. Rates of 2-4 gpm. per square foot are used in public water supplies rather than the somewhat higher rates used for the army units. The size of the equipment required for this purpose can be visualized from the fact that a standard unit 20 in. in diameter has an effective filter area of about 25 sq. ft.[A51]

Taste and Odor Control at Shreveport, La.

The water supplied at Shreveport is of the class known as "low alkalinity, highly colored, swampy water." In the spring there are abundant growths of algae and microscopic organisms in the reservoir. Various methods of taste and odor control were tried during 1946 and 1947 and the following conclusions reached: Superchlorination of the raw water to a 2.0-3.0 ppm free chlorine residual did not remove the woody taste and odor; in fact, it tended to accentuate them, requiring the use of more activated carbon to produce a palatable water.

Laboratory tests on the raw water, employing both superchlorination and low doses of chlorine, showed that activated carbon was more effective in removing the tastes and odors present when the latter type of chlorination was used. Similar results were found in the plant-scale application of carbon.

Laboratory tests showed that activated carbon was even more effective in removing tastes and odors present in the raw water when the chloramine treatment was used.



Courtesy Journal AWWA

Magnesium anode installation.

It is proposed to apply copper sulfate to the lake when needed; chloramine treatment of the raw water, and activated carbon in the settling basin.[A53]

Cathodic Protection Of Waterworks Structures

Eleven national organizations are cooperating in a study of cathodic protection through a "correlating committee." This committee will issue a series of bulletins on the subject, the first of which appeared in the May Journal of A.W.W.A. In this the committee says that "corrosion prevention properly starts with the design of structures and equipment, including the selection and placement of materials—in particular avoiding the contact of dissimilar metals—so as to minimize corrosion possibilities." For preventing corrosion of buried structures, accepted techniques are properly engineered coatings, or cathodic protection, or a combination of the two. Most coatings will deteriorate or become damaged in time, any defects focusing corrosive action and hastening local damage.

For reducing corrosion on older structures or insuring continued protection with newer coatings, the use of cathodic protection is indicated. For this, two types of current source may be used; direct-current generators or rectifiers connected positively to the anodes and negatively to the structure, if considerable current is required; or, where less current is required, anodes can be used which will self-generate the needed current. When masses of magnesium, aluminum or zinc are buried and connected to a steel or lead structure by insulated wires, they will generate current. Under favorable conditions these anodes may last several years.

Some of the current introduced to protect one main or other underground structure may enter, traverse and leave a neighboring structure on its way, causing corrosion of such structure at the point where it leaves it. This can be prevented by joining the two structures with a wire drainage bond. Two or more reasonably adjacent structures can be protected by a single cathodic system.[A47]

In designing a cathodic protection system for a water tank, perhaps the most important single consideration is the effect of water characteristics—dissolved solids, hardness, dissolved oxygen, chloride content, pH, specific resistance. The conductivity of a water is almost directly proportional to the dissolved solids content, and this will determine the distance the anodes should be placed from the walls of a protected tank to minimize the voltage required. The type, size and spacing of anodes is predicated, first, on the necessity of distributing the protective current to all parts of the structure and, second, upon such considerations as the size and shape of the structure, water characteristics and temperature. If there is a large-diameter steel riser pipe there should be a separate full-length anode in it supplied from a separate circuit.

The anode may be of either the expendable or the nonsacrificial type, the former including iron, carbon steel, chrome steel, aluminum, etc., and the latter including carbon, graphite and platinum. Of the expendable anodes, certain aluminum alloys are most satisfactory. Of galvanic anodes, magnesium, aluminum and zinc are commonly used. For aggressive water, painting the surface reduces the current requirements. Even with nonaggressive water, painting will reduce the installation and operating costs.[A47]

Cathodic protection of the entire un-

derground piping of the city of Lake Jackson, Texas, was installed in 1946, using magnesium as a galvanic anode. Previous to this, leaks had been occurring in the galvanized service pipes, as many as six a month at one time; but not one new leak has occurred since the installation. Magnesium was selected because it has the greatest solution potential of all the commercially available anodic metals. Also 1 lb. of magnesium has the electrochemical equivalent of 1,000 amp. hr. It has been demonstrated that an alloy containing 6% aluminum, 3% zinc and only traces of other metals exhibited better over-all performance characteristics than commercially pure magnesium. In this installation the magnesium anodes are in the form of cylindrical ingots placed in augered holes 3 to 6 ft. deep located about 10 ft. from the service pipe and 2" larger than the ingots, the annular space around the ingot being filled with a slurry of 75% bentonite clay and 25% gypsum. A more economical packaged anode called a "Galvo-Pak" is made by the Dow Chemical Co. Field tests have indicated that, under normal conditions, approximately 500 amp. hr. per pound of magnesium will be realized; and that a 16 lb. anode will have an effective life of 7 to 10 yrs. The maximum potential increase in this installation did not exceed 0.3 volt; over 1.0 v. might injure bituminous pipe coatings.[A48]

Water-Borne Outbreaks, 1938-45

Data on water-borne outbreaks in the United States during 1938-45 inclusive collected by the U. S. Public Health Service were studied by the authors, and a statistical breakdown prepared. They note that outbreaks still occur, there having been 327, with 111,320 cases (among the 80,000,000 consumers), during the eight years. Inadequate control of filtration or chlorination processes was considered to be responsible for a high percentage of the cases. Distribution system contamination through cross-connections and back-siphonage was responsible for 42% of the number of cases. Private supplies ("private" referring not to ownership but to the service rendered, such as hotels, resorts, summer camps, etc.) were responsible for 70% of the outbreaks, more than half of them ground water supplies without disinfection. They conclude that disinfection should be mandatory for both surface and ground water supplies in all water systems, and those serving populations of 100 or more should be under the supervision and control of county or state health authorities.

Of public supplies, untreated surface supplies accounted for only 15 outbreaks, and untreated underground supplies for 25 outbreaks.[A50]

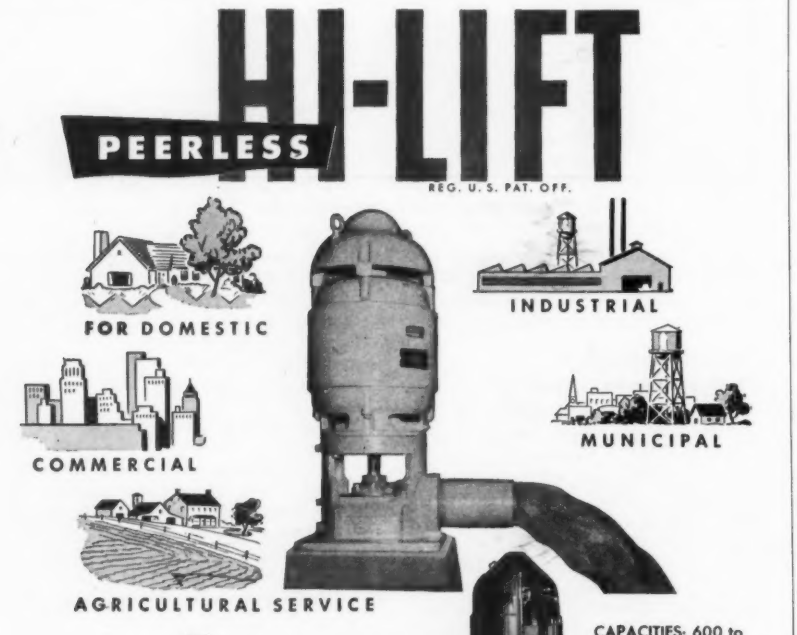
Power Developed at The Quabbin Reservoir

The Quabbin Reservoir of the Boston Metropolitan Water District is required by the State to release continuously a sufficient quantity of water to insure a flow downstream of 20 mgd. This discharged water is available for creating hydro-electric power, and is estimated to amount to 137 mgd under a head of 145 to 100 ft., producing 1,680 hp. to 945 hp. as guaranteed by the manufacturer of the turbine. With turbine and generator both operating at 600 rpm, the latter is rated at 1,500 kva, 0.80 power factor. Test runs were conducted last September.

The New England Power Ass'n has contracted to take 4,480,000 kwh a year of this current at 0.625 cts per kwh, and it is estimated that, for at least ten years, there will be an additional 4,680,000 kwh which is expected to bring 0.3 ct.; giving a total income of $42,000. The equipment and installation cost $115,000, and the fixed charges are estimated at $7,900 and the operating charges at $8,700, giving a net income of $25,400. [B6]

Management-Employee Relations

To get as great efficiency in public business as do large private corporations, there must be recognition of two things: 1—People are the most important element in the public service; 2—



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the basic wants and needs of public employees must be met if they are to produce. Some of these wants and needs are: 1—Knowledge of the objectives of the organization of which they are a part, their duties and privileges; 2—Wages equal to those for equal work in other public or private employment, with protection from decrease in purchasing power, job training, and promotions or other rewards for work well done. 3—Access to top-side management for presenting wants, needs and suggestions; protection of survivors in event of death, and provision for old age. A code embodying these should be adopted and published.

For the most effective operation, the ideas, thoughts, efforts and abilities of every member of the organization must be utilized. Suggestions by employees are valuable, for they generally know more about their jobs than the chief administrator is likely ever to know.[F21]

Pneumatic Storage Tanks

A pneumatic storage tank serves the two-fold purpose of maintaining domestic pressures within a selected range and of supplying a continuous domestic demand with intermittent operation of a pump. The initial cost is low, but in terms of cost per gallon of storage it is more expensive than an elevated tank or reservoir, for the useful capacity within the desired pressure range is only a small fraction of the full volume of the tank. Therefore pneumatic storage rarely is large enough to afford much fire protection. However, it may frequently be justified for improving water service on the fringes of a distribution system serving residential areas, or for villages of a few hundred population. The author furnishes a "Pressure-storage relations chart" to assist in calculating the size of tank required for any condition as to capacity and pressure range.[G24]

Distilling Sea Water

After many years of research and experience, an efficient vapor-compression distillation apparatus has been developed. This consists of four main pieces of equipment; (1) a power unit to drive the vapor compressor; (2) a vapor compressor specially designed to compress steam from atmospheric pressure to a higher pressure and temperature, thus providing the heat for the evaporator; (3) a standard vertical evaporator, in which the salt water is boiled, the steam thus generated being condensed to form the distillate; and (4) heat exchangers for cooling the distillate by transferring the heat from it to the incoming sea water. The overall water-to-fuel ratio varies from 0.655 lb. of water produced per 1,000 Btu for a single-effect steam still to 10.81 lb. for a diesel-driven vapor compression still. A plant of the latter type for 300,000 gpd cost $2,126,000. This type of plant produces pyrogen-free, sterilized, distilled water, with a negligible content of total dissolved solids and gases.[A54]

Residential Soft Water Service

On June 1, 1947, approximately 165 manufacturers were offering base-exchange domestic water softeners, and over 400,000 were in use. There are several distinct softening arrangements in use for providing domestic soft water services. All use steel pressure tanks in which are placed base exchange minerals, which are serviced by the company. In those of the Culligan and Filter-Soft corporations, the spent mineral is removed for regenerating by removing the entire tank, replacing it immediately with a fresh one. In the Servisoft, the mineral comes in bags, and a spent bag of mineral is replaced with one of regenerated material, the tank being left in place. In the McKays and Lindsay system, the mineral is regenerated in the tank, which is installed permanently; these can be bought outright and serviced by the consumer if he wishes. The customer-owned softeners cost $100 to $125; the service units rent for $2.60 a month.

It was calculated that in Madison,

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In more than 75 years' record-making, Mathews Hydrants have proved as infallible as human ingenuity could make them. No water can reach the operating thread to rust it or deposit sand. The operating nut is securely shielded against rain, dust and dirt. No ice can form—even in coldest weather. The drain valve is positive and automatic, the main valve true compression-type. All the working parts are housed in a removable barrel, which can be replaced in a few minutes—minutes that could *count*.

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Wis., where 40% of the water consumers had residential water softeners, they had spent enough for these to pay for a municipal plant for softening the entire supply of the city. Most municipal softeners do not decrease the hardness below 85 ppm. Laundries in New York City, where the hardness is 42 ppm, report a soap saving of 50% where water of zero hardness is used; and it is estimated that where the water has a hardness of 85 ppm, reduction to zero hardness would permit a saving of 75% of the soap. [A30]

Before installing a home zeolite softener, the company analyzes the water so that the correct mineral may be used to remove not only hardness, but iron and manganese, taste and odor, and other undesirable qualities. The domestic requirement is best fulfilled with a zero hardness water; as also is that of commercial establishments; but the requirements for industrial consumption, which in most cities amounts to 30-50% of the total, are met by a water softened to 85-105 ppm. The additional cost of removing the hardness below this would fall upon all consumers; moreover, some calcium carbonate is required for protection of plumbing against corrosion; and few municipalities reduce the hardness below 85 ppm. Soft water service offers an opportunity for further reducing municipally softened water where this is desirable. [A31]

Removing Phenols From Water

An investigation of possible methods of removing or destroying very low concentrations of phenolic compounds from water solution led the authors to conclude that the use of flocculants is unsatisfactory; that the complex iron salt formed by the reaction of phenol and ferric chloride does not occur to an appreciable extent in the low concentrations typical of water treatment; that it is improbable that an organic reaction can be utilized in the removal of such low concentrations; that the acid-chlorate method for producing chlorine dioxide for this purpose was unsatisfactory; and that the hypochlorite ion activation of sodium chlorite appears to have many commercial possibilities. [P19]

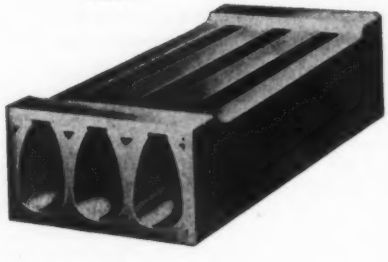
Closing Valves When Main Breaks

A break in a large main calls for the speediest possible action in closing the valves necessary to stop the flow from the break; followed by draining the line and repairing the break. This involves speed in receiving notification of the break and in getting a crew there promptly. Preparation for such an emergency should be made by training crews in a planned procedure, so that they will know what to do when they get there and exactly how to do it. Immediate knowledge of a large leak can be furnished by rate-of-flow meters and pressure gauges on strategic mains which will operate a bell or light if there is any sudden increase of flow or drop in pressure. To get a crew promptly to the break, short-wave radio is a great help.

To instruct the crews what to do in case of a break in any given spot, the Division of Water of Newark, N. J., has divided its principal mains into sections, a section being the portion between two adjacent main valves; and an "operating sheet" is drawn up for each section of each main and copies furnished to the crews. Each valve and hydrant in the city has a number and the operating sheet for a given section instructs what valves to shut and in what order; the exact location of each valve, its size, and the number of turns required to close it. Next, what valves to open (or check that they are open) to see that water can reach every other section. Finally, what blow-off valves to open and what air valves to check to unwater the line.

Payne Dean valve-operating machines are used on valves 20" and larger. Eventually cone valves will replace gate valves as main control valves throughout the Newark system. They require far less time to operate and only one man. A 24" cone valve in a 60" line under 52 lb. pressure can be closed with only 72 turns, whereas a 48" gate valve on the same line

For Trickling Filter Beds



NATCO Unifilter Blocks

Natco Unifilter Blocks of salt glazed hard-burned clay, light weight and single unit, are rapidly and economically installed. Egg-shaped run off channels insure maximum flow while the three long top slots, combined with adequate duct area, provide effective ventilation of trickling filter bed. Their structural strength results in low repair and maintenance costs. *Write for literature.*

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would require 6 or 8 men about ¾ of of an hour making 450 turns.[A36]

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Control of Cross Connections in Houston, Texas

In his report for 1947 Clyde R. Harvill, Sanitary Engineer of the Water Division of Houston, Texas, said that cross-connection control became increasingly important with the accelerated building program in the city in 1947. During the year new buildings and additions to old buildings, which are potential large water consumers, were surveyed in the preliminary stages of construction to insure design in conformity with sanitary standards. Additional surveys stressed the elimination of direct connections with aqua gasoline systems, flushometer type toilet valves without vacuum breakers, surge tanks without the overflow 6" below the inlet, sewer sump pumps, direct connections between the city and private well supplies, and unauthorized usage of water from fire lines. Special emphasis was placed on the elimination of sanitary hazards in the public schools. Many of the old school buildings had flushometer type toilets without vacuum breakers and drinking fountains with inlet supply lines below the overflow rim of the basins. Through the cooperation of school officials these hazardous conditions were eliminated as located.

An Effective Shut-Off Valve

Designed for heavy hydraulic service, this valve, though rated at 50 lbs., will give bubble-tight shut-off up to 80 psi, and commercially tight shut-off at 100 psi. A rubber spool, combined with wedge closure of an angular setting disc insures indefinite operating life. *R-S Mfg., Co., Philadelphia, Pa.*

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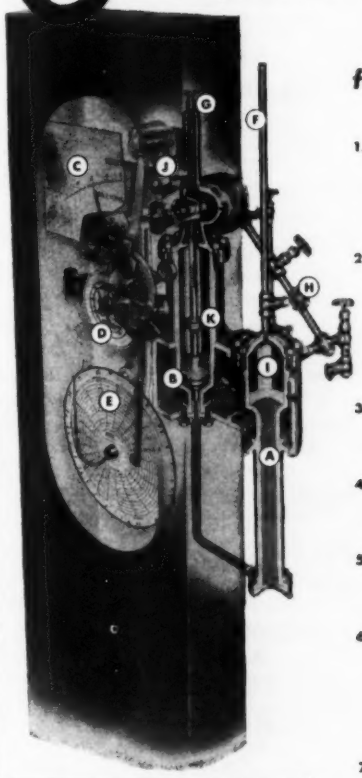
THE BEST BUY

for Water and Sewage Works



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3. BUILT-IN CALIBRATING DEVICE:
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4. UNAFFECTED BY TRAPPED AIR:
Trapped air has no effect on accuracy; air easily removed through a valve at the top of each well (G and H).

5. MEEHANITE IRON:
Mercury wells (I), main bracket on which mechanism and wells are mounted (J), and float (B) are high-tensile MEEHANITE iron.

6. HIGH ACCURACY – WIDE RANGE:
Registration with plus or minus 1% (response to differential induced by actual flow rate) over range of 100% to 6⅔% capacity for Model MDUA; within plus or minus ½% from 100% to 50% and within plus or minus 1% from 50% to 5% of capacity for Model MDUAX.

7. POSITIVE OVERLOAD CHECK:
Check valve (K) prevents loss of mercury even at extreme overload differentials.

8. LONG LIFE:
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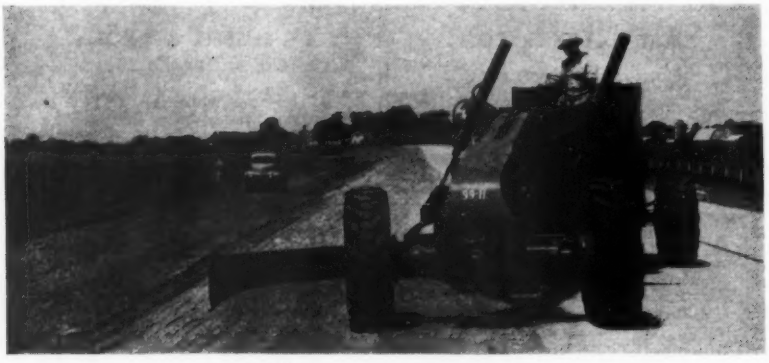


The Austin-Western 99-H power grader.

For Better Road Construction

This "99-H" power grader, the latest in this line, has all-wheel drive and steer, full hydraulic controls, high-lift blade, completely reversible, with full hydraulic control. The blade can be so set as to reach 10 ft. 1½ ins. beyond the rear tire, using the maximum offset. Banks can be sloped to 90°. An unusual variety of attachments are available for doing all kinds of extra jobs. *Austin-Western Co., Aurora, Ill.*

Entrained Air Indicator

This device is for measuring the percentage of air entrained in fresh concrete mixtures. A sample of the concrete is placed in the bowl, the cover clamped in place, water added and pressure applied. The contraction in the volume of air in the concrete is measured by the lowered water level, and is indicated by a scale showing the gross air per cent. *Central Scientific Co., 1700 Irving Park Road, Chicago, 13, Ill.*

Hot or Cold 1,000-lb. Bituminous Plant

This is a new batch-type 1,000-lb. bituminous mixing plant for either hot or cold mixes. Batchers weigh and proportion each size of aggregate and add the required amount of bitumen. This plant is designed for a fairly steady demand of paving mixes, and can be quickly and easily moved. *Iowa Mfg. Co., Cedar Rapids, Iowa.*

Earth Auger and Loader on Tractor

A front-end loader and a rear-mounted earth auger can be mounted on

Earth auger and loader.

a Case VAI tractor, as shown herewith. The manufacturer gives us no dope on the auger, but the loader is ⅜-yd. struck capacity. Fork lift, angling dozer, crane hook and wide bucket can also be mounted in a similar way. Looks like a handy municipal tool to set posts, handle pipe and other material, load snow, bulldoze, plant trees and shrubs, etc. All these units operate from a common rear equipment hitch with hydraulic down pressure. *Construction Products Corp., 4345 East Imperial Highway, Lynwood, Calif.*

Portable Bulk Cement Batching Plant

Designed for the utmost portability, it is possible to erect a 200-barrel bin quickly, with full provision for expansion to 400, 600 or even 800 barrels total storage capacity. Each bin section is a one-piece welded assembly. The cement weighing batcher is also shipped and erected in one piece. The cement elevator has a capacity of 50 tons an hour. *Blaw-Knox Co., Pittsburgh, Pa.*

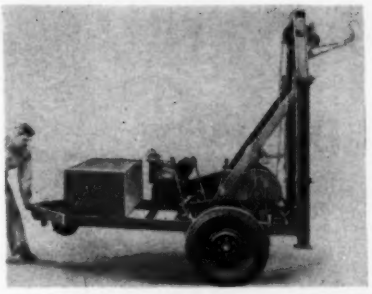
Safety Valve for Air Tools Protects Workmen

This safety valve is designed to prevent injury to workmen using air tools. This is accomplished by checking the air instantly and automatically whenever the connection at the end of the line is broken to change a tool. It is not necessary to go to the compressor to turn off the air. If a high-pressure air line breaks, no one will be injured. It is said to check air waste. It has other important advantages, too. *Danielson Safety Valves, Inc., PO Box 1629, Richmond, Calif.*

Ann Arbor, Mich., windrows leaves with a motor grader and picks them up with an Athey loader. An estimated 500 cu. yds. per day is removed in this way, loading into larger trucks.

For Speedier Sewer Cleaning

Ten major mechanical features to speed power cleaning are said to be built into these new power sewer cleaners. These include the new folding third wheel, pulls up to 10,000 pounds, and a new safety clutch. The third wheel simplifies placing the machine and towing to and from the job. For fuller description of these and other features write *Flexible Sewer-Rod Equipment Co., 9059 Venice Blvd., Los Angeles 34, Calif.*



New Flexible Sewer Cleaner.

Cut and Spray Weeds at the Same Time

This unit mounts four spray nozzles on a boom behind the sickle bar; these can spray the entire 3-ft. width of the mower. A baffle plate guides the spray and prevents drift. Chemical is carried in a 3½-gal. tank. In addition to weed-killing, ammonium sulfamate can be used on poison ivy. *James Cunningham, Son & Co., Rochester, N. Y.*

Cunningham mower and sprayer.

Pioneer Crushing Units

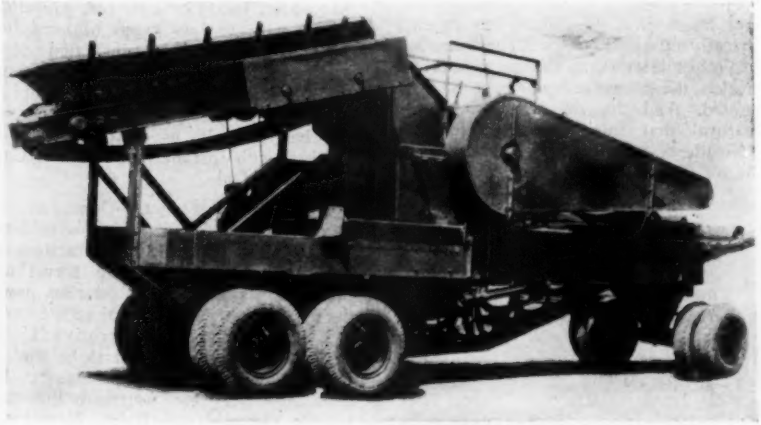
The Pioneer 145R is a semi-portable crushing and screening plant, with 1524 jaw and 30x16 roll crusher, which is rated at 40 to 50 tons per hour of three sizes of material, taking rock up to 12-inch. A new 2-unit portable is also available. This has a 1536, 2036 or 2436 primary and 40x22 or 54x24 secondary crushers. A gravel primary is also available. Full data on all three units from *Pioneer Engineering Works, Minneapolis 13, Minn.*

For Spraying Weeds—A Sprayer and Chemicals

This is a powered sprayer with one moving part that can be attached to a wheel tractor, leaving the power takeoff free for other work. There are no belts or exposed moving parts and the rate of application is easily adjustable. This company also makes a sprayer transport, a 2-wheel, rubber-tire, trailer, easily connected to trucks or tractors. For information on this equipment and on a wide variety of weed-killing chemicals, write *Howard Hanson & Co., Beloit, Wisc.*

Pneumatic Sponge Pump

This pump isn't designed for pumping sponges; it takes its name from the fact that the impellers are mounted at the extreme lower end, thus taking up solids as a sponge takes up water. It will handle sand, pulverized rock, etc., up to ⅝". Lowest operating level is 3" from the bottom of the sump. Used for sumps, tanks, basins and manholes. At 90 psi., capacity is 25 to 300 gpm. *Byron Jackson Co., Pump Division, Box 2017, Terminal Annex, Los Angeles 54, Calif.*



Pioneer crushing and screening plant.

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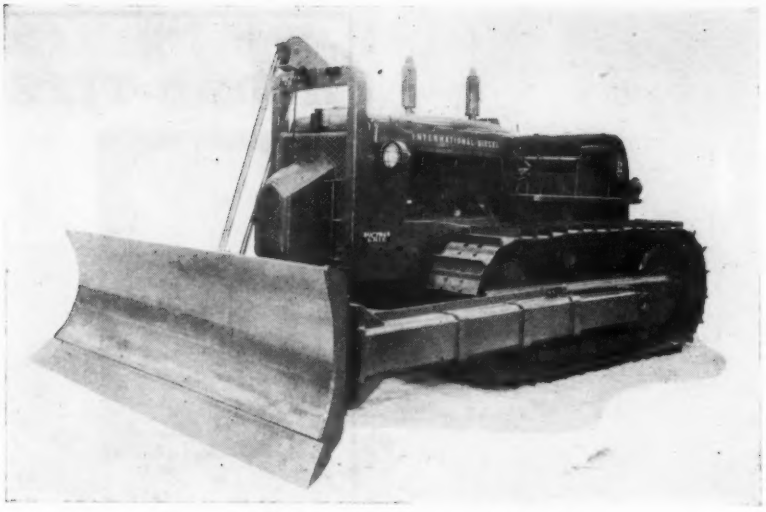


International TD-24 tractor with Bucyrus-Erie bullgrader.

Scooter-Loader Saves Labor

This inexpensive front-end loader is stated to do the work of 4 or 5 men

Arrow scooter loader.

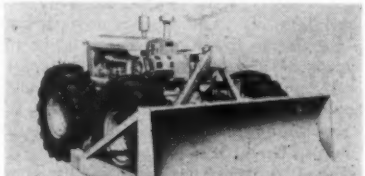
with wheelbarrows on such work as charging concrete mixers, moving and loading loose materials, handling sand, cement and gravel, etc. Bucket capacity is 8 cu. ft., and the equivalent load is 1200 lbs. Drive is on the front wheels, and there are 4 speeds up to 15 mph. *Arrow Contractors Equipment Co., 2020 Walnut St., Chicago 12, Ill.*

Killing Brush to Ground Level

Hormone herbicides have streamlined brush control, eliminating the need, in many cases, for heavy equipment. When properly used, these chemicals will kill brush to the ground level. Best results are obtained at the lowest cost per acre with brush between 1 and 3 ft. tall, and never over 4 ft. Action is quick. Missed spots show up in 24 hours. Ought to be excellent for roadside brush control. *Asplundh Tree Expert Co., Jenkintown, Pa.*

300-hp. Bulldozer and Pusher

A 25-ton, 300-hp. pusher and bulldozer, has 24x29 pneumatic tires and will travel 13.6 mph. It is designed as a pusher unit for large scrapers and



LeTourneau bulldozer-pusher.

for bulldozing. The blade has an electrically operated control. There are lots of other interesting design details for which the manufacturer must be consulted. And, by the way, it is only natural that this super-size bulldozer is made at the Longview, Texas, plant of *R. G. LeTourneau, Inc., Peoria, Ill.*

Chemically Inert Paints and Coatings

These paints have unusually good adherence and heat resistance, and are easy to apply—with a brush, spray or dip; and can be air-dried or baked. Acids, alkalies and most corrosive materials have no effect on them. They will withstand continuous exposure to 350°F. They include special finishes for masonry and concrete. The Duramite pH folder contains good information. *Morton Chemical Co., Greensboro, N. C.*

Gorman-Rupp Centrifugal Self-Priming Pumps

The G-R line of new pumps includes units from the 7M, 2", up to the 125M, 8". The high-speed priming is illustrated by the manufacturer's statement that the 4" pump will prime at 15 ft. suction in 36 seconds and at 25 ft. suction in 65 seconds; the 6-inch primes at 15 ft. in 21 seconds and at 25 ft. in 44 seconds. These units will be shown at the Road Show. *Gorman-Rupp Co., Mansfield, Ohio.*

Portable Roadway Crushing Unit

This is a portable crushing unit designed primarily for towing behind the Athey force-feed loader. It picks up, elevates and delivers materials from the roadway into the crusher hopper. This material is crushed to the desired size and deposited back on the roadway, eliminating the need for transporting it to and from a central crushing plant. *Athey Products Corp., 5631 West 65th St., Chicago 38, Ill.*

Tool Boxes.—Fire-proof, tamper-proof and weather-proof tool boxes, trailer mounted, are described in a folder issued by Littleford Bros., Inc., 452 East Pearl St., Cincinnati 2, Ohio.

Bucket Loaders.—Two heavy-duty bucket loaders, the P-10 and the Q-10, are described in a new bulletin by N. P. Nelson Iron Works, Inc., 10E Clifton, N. J. These will strip and grade as well as stock-pile. They will handle material containing up to 15% of 6 inch cube pieces.

Insulated Piping.—Here are four excellent booklets on the various uses of insulated piping. They contain a great deal of sound information on designing such lines. No. 44 covers conduits, underground or overhead, for hot water, steam or oil lines, prefabricated, with various types of conduits. No. 4708 treats of insulated pipe systems; and No. 4801 covers distribution piping with insulated pipe units. No. 4713 is a 12-page booklet on central heating, with especial reference to a Pittsburgh installation. Ric-wiL Co., Cleveland, Ohio.

To Eliminate Odors.—Odorid is the name of a deodorant which is said to work on the principle of attraction of the minute particles which travel on the smell waves. It is an odorless powder; it gives off no chemical substances; it is non-toxic and non-corrosive. Used dry or with water. Ought to be useful in and around sewage plants, refuse handling places, etc. American Processing Co., Hippodrome Bldg., Cleveland, O., will send details.

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Save Money
Save Time
STERLING MACHINERY CORP.
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JOBS FOR ENGINEERS

Jean Vincenz, former Colonel of the Sanitary Corps and Corps of Engineers, who is now Director of the Department of Public Works of the County of San Diego, Calif., writes that an examination will be held shortly to qualify for a position as chief of the engineering division; the examination will be open to residents of any state. Salary will range from beginning at about $6,000 to a top of a little more than $7,000. Address inquiries to Mr. Vincenz at 4005 Rosecrans St., San Diego 10.

* * *

PERSONAL ITEMS

Joseph B. Diamond, of the Bronx, has been appointed Deputy Commissioner of Public Works of the City of New York.

E. W. Bennison of Edward E. Johnson, Inc., St. Paul, Minn., who graduated from the University of Nebraska in 1909, has been awarded an advanced professional degree by that university. His thesis was "The Development of Ground Water." He will be remembered as the author of a remarkable series of articles, later published as a text, on "Ground Water—Its Development, Uses and Conservation."

Joseph M. Wafer, a familiar and favorite member of the water works industry, has been elected a vice-president of the West Virginia Pulp and Paper Co., makers of Nuchar.

Clarence I. Sterling, Jr., who has done such a fine job as director of Health and Sanitation Division of the Institute of American Affairs, has been elected the first president of the Inter-American Association of Sanitary Engineering. Alberto Ortiz Irigoyen of Mexico is first vice-president.

Harold W. Streeter, who has been in charge of the Public Health Service Water and Sewer Investigations at Cincinnati, has retired after 34 years of service. He will be succeeded by Vernon G. MacKenzie. A letter from Mr. Streeter appears on another page of this issue.

James J. Souder, former Lt. Col. of the Sanitary Corps, and chief architect for hospital construction for the Medical Department during the war, is now associated with York & Sawyer, architects, at 1308 18th St., Washington, D. C. If you have a hospital to build, the editor can recommend Jim Souder as tops in knowledge, good sense and pleasing personality.

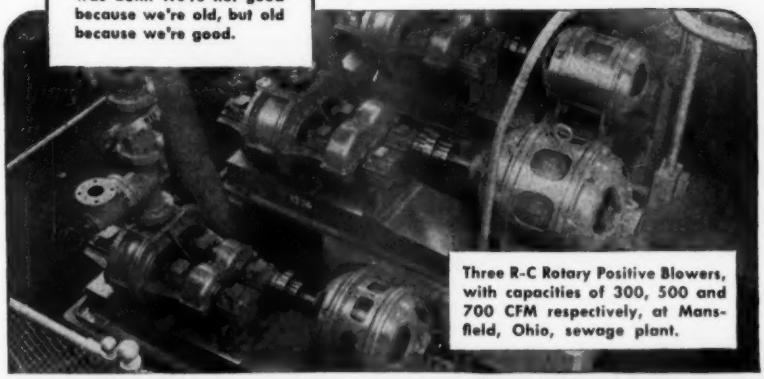
John M. Palmer, sales manager of the Lee Clay Product Co., Clearfield, Ky., has been elected president of the National Clay Pipe Manufacturers, Inc., succeeding G. Lawrence Avery of Sioux City, Iowa.

O. L. Kipp, Assistant Commissioner and Chief Engineer of the Minnesota State Highway Department, has been elected president of the Mississippi Valley Conference of Highway Departments.

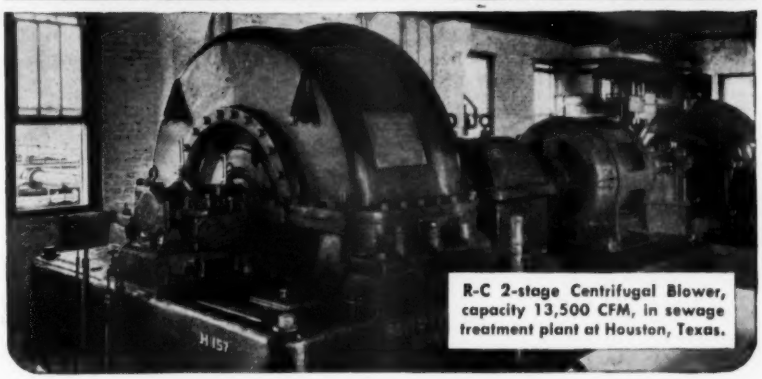
Oil was first produced by drilling in 1859, five years after the first Roots Blower was built. We're not good because we're old, but old because we're good.

NO "HEDGING" ON BLOWER QUESTIONS FROM

R-C dual-ability



Three R-C Rotary Positive Blowers, with capacities of 300, 500 and 700 CFM respectively, at Mansfield, Ohio, sewage plant.



R-C 2-stage Centrifugal Blower, capacity 13,500 CFM, in sewage treatment plant at Houston, Texas.

When you ask Roots-Connersville engineers about blowers or gas pumps for sewage plant or waterworks applications, you'll get unbiased answers, without "hedging" between Centrifugal or Rotary Positive equipment.

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Our long experience in supplying sewage plant and waterworks equipment, including meters and vacuum pumps as well as blowers and gas pumps, results in reliable and economical performance of R-C units.

For straight answers that mean long-time satisfaction, consult R-C *dual-ability*.

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New Technical Booklets and Catalogs

You can obtain copies of these publications by writing either the manufacturer or the Editor.

Highway Data

Improving Highway Shoulders.—This 24-page text book gives a step-by-step procedure covering several types of "traffic resistant" turf shoulders. Also included are types of border strips or pavement edgings. The types treated are selected to include regional needs. It is intended for designing, maintenance and roadside improvement engineers. Ask for Bulletin 30. Seaman Motors, Inc., 305 North 25th St., Dep't. 14, Milwaukee, Wisc.

Stone Breaker.—This machine (the 3030) will take stone that will pass through a 30-inch opening, but not over 36 ins. long—quite a pebble—and will produce material from dust to road ballast stone in one pass. The 2020 will take stone up to 20x20x36, with the same end result. On limestone, depending on the speed, maximum size will be 1¼" to 2½" stone. New Holland Mfg. Co., Mountville, Pa.

Cinder and Sand Spreader.—A 4-page folder describes the "Berna" spreader which spreads any size material, sand to 1-inch stone, and has a micrometer control for regulating the amount of material spread. Good Roads Machinery Co., Minerva, Ohio.

Colored Sidewalks.—What color sidewalks do you want? There are advantages to colors that you may not have thought about. For information on what to use and how to do it, write A. C. Horn Co., Inc., Long Island City 1, N. Y.

Fast Road Maintenance.—A 4-page folder describes the use of the FWD truck with the HG under truck maintainer. FWD Auto Co., Clintonville, Wisc.

Sanitary Engineering

Ion Exchange Principles.—This booklet gives (1) a general discussion of ion exchange principles, with diagrams, formulas and illustrations; and (2) technical data on each of the commercially available types of ion exchange materials made by this company, with information to predict accurately ion exchange performance under specific operating conditions. National Aluminate Corp., 6220 W. 66th Place, Chicago 38, Ill., will send copies on request.

Flocculation Equipment.—Equipment for the pre-treatment of water in chemical mixing is described and very well illustrated in Bulletin 48-39. Complete information and data for a typical installation, with diagrams, are given. Chain Belt Co., 1600 West Bruce St., Milwaukee 4, Wisc.

Concrete Forms.—A most valuable 54-page book on "Form Engineering" is available. It discusses ties and spreaders, and gives tables for the most economical design of forms. In addition it shows many applications of forms, clamps and tie rods; it discusses small retaining walls, and how to construct them. For your copy, write Williams Form Engineering Corp., Grand Rapids 7, Mich.

Letters to the Editor

THAT CALFDOZER:

Here is a picture of the Calfdozer at work. It is taken from the 59th Annual Report of the Metropolitan Water, Sewerage and Drainage Board, New South Wales.

THOMAS J. SKINKER,
Water Commissioner,
St. Louis, Mo.

(Ed. Note: Sorry the picture won't reproduce. It is a small track-laying tractor, with a little blade on the front. The operator sits with his feet practically on the blade. The illustration shows the machine at work backfilling a trench. Thanks, Mr. Skinker.)

THAT NAIL PICKER-UPPER:

We were much interested in the note in "From our Readers" in the May, 1948, issue, about the request from the Continental Gin Co. for a magnet device for picking up nails, etc., which cut truck tires. We are enclosing a set of pictures showing just such a device, which is one of the many jobs which can be performed by the Dempster-Dumpster. The operation of this outfit is very simple. . . . This device . . . can do the sweeping at any desired elevation, raise the magnet, and dump . . . It is a coincidence that the Continental Gin Co. has one of our small Dempster-Dumpsters mounted on a tractor. We have written our Birmingham representative to contact them.

Dempster magnet.

H. W. JONES,
Chief Engineer,
Dempster Bros., Knoxville, Tenn.

(Ed. Note: We thank Mr. Jones and Dempster Bros. for taking care of this matter so promptly. Herewith is one of the pictures sent us. Seems like if you have troubles, write the Editor and get help.)

AN OLD FRIEND RETIRES:

Since going on terminal leave, so many things to be done at our home have claimed attention that I have just gotten around to acknowledging the many friendly messages received last April. I am not at all unhappy about retirement, having had 34 years of service and feeling quite ready for a change. Thus far I have no definite plans for the future, but shall not forsake our profession if an opportunity to serve should arise. Just at present, I am planning to do some unfinished writing.

HAROLD W. STREETER

IT WAS AND IT HELPED:

If it is raining in New York, the following letter which I just received may bring you a bit of sunshine. Here is the letter:

"Dear Sir; Sometime Ago I Purchased A Septic Tank From You People, And Have No Complaint Against It. But One Of Our City Council Thinks He Is God and Knows Everything, So He Orders Me To Put Waste Water That Is From Bath Tub and Washing Machine Through The Septic Tank, Now I Claim That Is Not Rite And That It Will Destroy The Mold That Makes The Tank Function. Please Tell Me Whether I Should Run Waste Water In Them Or No, Thanking You Many Times"

Yours very truly
BENJAMIN EISNER

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These helpful booklets are free. Just circle numbers you want on coupon and mail or write the manufacturer direct and mention PUBLIC WORKS. This service is restricted to those actually employed in public work.

NEW LISTINGS

Time for a New Transit Level?

1. Two are described in attractive illustrated folders. One, the Warren-Knight, is "used like a transit, checked like a level." Another, the Sterling Convertible Level. Investigate free trial offer. Use coupon or address Warren-Knight Co., 136 No. 12th St., Philadelphia, Pa.

You Can Get Tanks Built Promptly

2. A new booklet gives not only the salient facts on what Preload Tanks for water works and sewage works are, but how you can get them without waiting. Address: The Preload Companies, 20 Lexington Ave., New York City.

New Model Air Compressor

4. The "160" compressor is described in Bulletin C-160-8; the 500' and 600' compressors are described in Bulletin 6-JC-7. Write Jaeger Machine Co., Columbus 16, Ohio.

New Type Coating For Concrete and Steel

6. Zerok is a vinylite-type coating, acid and alkali protective, for any concrete or steel application in the sewerage or water works field. An 8-page folder tells where and how to use. Write Atlas Mineral Products Co., Mertztown, Pa.

Double-Duty Softener And Dealkalizer

8. A 12-page booklet describes how this double-duty Zeo-Karb softener and dealkalizer works and how it is applied to various industrial problems. Ask for Bulletin 2418. The Permutit Company, 330 West 42nd St., New York 18, N. Y.

Long Distance Recording of Level-Pressure-Flow

9. Be sure to get Bulletin 358 on the "Chronoflo Telemeter" that brings accurate records of flow, level, pressure , temperature, gate positions, weight, etc., from widely scattered locations to a central operating point. Widely used in Water and Sewage plants. Write Builders-Providence, Inc., 16 Codding St., Providence 1, R. I.

New "Humdinger" Pump Catalog

10. Before you buy another pump you will want this beautiful new brochure No. 4053 illustrated and with useful data and operating hints. Issued by Ralph B. Carter Co., Hackensack, N. J. Shows full line of Humdinger Pumps. Address Carter direct or use our coupon.

MAIL THIS COUPON TODAY!

A New Answer to Some Old Waterworks Problems

12. That is what they call "Hypo-Chlorination of Water," a 75-page illustrated discussion of this live subject, in a booklet packed with helpful information. For your copy, address: Mathieson Chemical Corp., Dept. PW, 60 E. 42nd St., New York 17, N. Y.

All About Cement-Mortar Lining of Water Mains

13. Here, in a really beautiful booklet, is practically everything you need to know about this method of lining mains in place—the needs, methods, and results that will interest you. Centriline Corp., Dept. PW, 140 Cedar St., New York 6, N. Y.

How Elevated Water Tanks Can Save on Operating Costs

14. Beautiful new booklet on Horton elevated steel water tanks suggests ways to reduce pumping costs, increase capacity of systems, maintain uniform pressure, etc. Illustrates 7 models of welded, ellipsoidal-bottom, elevated steel tanks in full color. Write Chicago Bridge & Iron Co., 2115 McCormick Bldg., Chicago 4.

Hydraulic Dump Bodies For Every Purpose

15. There's a hydraulic hoist or dump body designed and built to fill your need. Hercules bodies are designed to do a specific job in less time and at a lower cost. Specifications and data on the complete Hercules line available without obligation by writing to Dept. PW, Hercules Steel Products Corp., Galion, Ohio.

Road Protection at Less Cost

16. There's no limit to the jobs you can handle with an Allis-Chalmers Package outfit consisting of the HD-5 Tractor with Tracto-Shovel and Model A-D Motor Grader. For booklets describing and illustrating these and other Allis-Chalmers Equipment write Dept. PW, Allis-Chalmers Tractor Division, Milwaukee 1, Wisc.

The Modern Way to Filter Swimming Pool Water

17. That's the title of a new bulletin full of facts about Bowser's new diatomite filter to produce clear, sparkling, clean water at low cost. Occupies small space, doesn't waste water. Gives sizes to use, performance charts, etc. Write Bowser, Inc., Dept. PW, Ft. Wayne, Ind.

Latest Facts on Marlow Pumps for Utility Use

18. Attractive new booklet U-47 tells all about Marlow centrifugal utility pumps in 1", 2" and 3" sizes. Gives test performance data. Featherweight aluminum units. If you are also interested in larger pumps, ask for G-47 too. Marlow Pumps, Dept. PW, Ridgewood, N. J.

Equipment for Treating Sewage, Water and Trade Wastes

20. A well prepared 44 page illustrated booklet on use and advantages of Flocktrols, Traveling Water Screens, Triturators, Sludge Collectors, Sludge Removers, Grit Collectors and Bar Screens made under the name of "Rex" for use in Trade Wastes, Sewage and Water Treatment by Chain Belt Company, 1722 West Bruce St., Milwaukee 4, Wisc. Contains a page of useful Conversion Factors.

Glazed Clay Blocks for Trickling Filter Underdrains

66. Illustrated bulletin describes the Natco Unifilter block of glazed, hard burned clay for underdraining filter beds. Write National Fireproofing Corp., Pittsburgh 12, Pa., for free copy.

Concrete Forms For Every Need

67. There's a form for your need whether it's concrete pipe for sewer, drain or irrigation; forms for roads, bridges, tunnels or manholes; or a special form problem. For folders telling just what these concrete forms can do for you write Dept. PW, Concrete Forms Corp., 43 Cedar Street, New York 5, N. Y.

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Mud Valves
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AND FITTINGS COMPANY
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Jointing Compounds and How They Are Applied

68. A new folder—just off the press—describes Flintseal Hot-Poured Joint-Sealing compound and illustrates joint preparation, material preparation and application of the compound. Series of pictures shows steps in application—plowing out old material from joint, wire brushing to clean old material off concrete, use of compressed air to clean dirt and dust out of joint, picture of completed joint, etc. On request from The Flintkote Co., Dept. PW, 30 Rockefeller Plaza, New York 20, N. Y.

Cinder Spreader with Heated Working Parts

69. By heating working parts from exhaust this dependable Baughman cinder spreader avoids metal breakage in cold weather and keeps conveyor chassis from freezing to the bottoms. Full details, specifications and exclusive advantages in new illustrated bulletin. Don't wait till winter. Get the facts now. Baughman Mfg. Co., Inc., Dept. PW, Jerseyville, Ill.

CONSTRUCTION AND MAINTENANCE

Data Book on Universal Concrete Cribbing

21. Shows typical sections for designing walls, pictures many applications, specifications, etc. Get the facts today about this economical reinforced concrete cribbing. Universal Concrete Pipe Co., Dept. PW, 297 So. High St., Columbus 15, Ohio.

Solve Your Drainage Problems This Easy, Permanent Way

28. Useful new 60 page catalog on standard corrugated pipe, multi-plate pipe and arches and 18 other drainage and related products for culverts, sewers, subdrains, flood control, airports, water supply and other types of construction. Ask for "Armco Products for Engineering Construction," Armco Drainage and Metal Products, Inc., Dept. PW, Middletown, Ohio.

Levels Sidewalks and Curbs Quickly and Easily

29. How the Mud-Jack Method for raising concrete curb, gutter, walls and streets solves problems of that kind quickly and economically without the usual cost of time-consuming reconstruction activities—a new bulletin by Koehring Company, 3026 W. Concordia Ave., Milwaukee 10, Wis.

Methods of Installing Steel Sheet Piling

30. Illustrated descriptions of both standard and interlock corrugated steel sheet piling of minimum weight, maximum strength, ease of handling with methods of installation are contained in a booklet. If you have a job involving piling write Caine Steel Co., Dept. PW, 1820 No. Central Ave., Chicago 30, Ill.

Speed Maintenance With This Portable Air Compressor

31. LeRoi Portable compressors in sizes from 60 to 500 c.f.m., gasoline or Diesel powered on mountings to fit your special needs. Same manufacturer makes both compressor and engine. Complete bulletin. Write LeRoi Company, 1770 So. 68th St., Milwaukee 14, Wis.

All of These Booklets Are FREE, and Many Are of Great Value. To Order Those You Need in Your Work Use the Coupon on Page 85.

Strong, Speedy, Low-Cost Maintainer Has Many Uses

22. BG Maintainer, a powerful speedy, low-priced machine for light road maintenance. Full details in illustrated folder. Huber Mfg. Co., Dept. PW., Marion, Ohio.

Useful Attachments For Your Industrial Tractor

24. Need a front end bucket loader that can be converted into a light plow or grader in a matter of minutes? Write for this folder that illustrates, describes and gives specifications of the Ottawa Industrial Front End Loader for industrial tractors. Loads earth, sand, gravel and other bulk material. Quick change over can be made to light bulldozer, V-type snow plow, grader or maintainer with attachments. Write Dept. PW, Ottawa Steel Products, Inc., Ottawa, Kans.

One to Two H.P. Air Cooled Engine for Dependable Power

25. New bulletin, illustrates many uses for Clinton 1 to 2 H.P. gasoline engines. Gives full specifications and power data. An economical, long lasting power unit. Write Dept. PW, Clinton Machine Co., Clinton, Mich.

Two-Way FM Radio Telephone Equipment for All Departments

26. For booklet describing and illustrating the Motorola Two-Way Radio Telephone or for specific recommendations concerning your application write to Dept. PW, Motorola, Inc., 4545 Augusta Blvd., Chicago 51, Ill.

Diesel Engines to Help You Build Profits

27. A new 28 page catalog just off the press titled "Superior Stationary Diesel Engines," is packed with facts that will help you build profits. For your copy write to Superior Engine Division, National Supply Company, Springfield, Ohio.

Open Steel Mesh Pavement for Bridges

72. A pavement that is self-cleaning, self-draining, light of weight, strong, durable, fireproof, economical and requires no maintenance, is described in a 24-page catalog by Irving Subway Grating Co., 5053 27th St., Long Island City 1, N. Y.

SEWAGE DISPOSAL

Non-Corrosive, Long Lasting Low Cost of Sewer Pipe

33. Get this new engineering data on clay pipe for sewers. Withstands acid, alkali and gas attacks indefinitely. Cuts maintenance costs to a minimum. Write Dept. P.W., National Clay Pipe Mfrs., 111 W. Washington St., Chicago 2, Ill.

Does Air Sabotage Your Pipe Lines and Pumps?

34. Automatic Air Release Valves for water, sewage and industrial uses automatically vent air accumulations. Ask for latest illustrated engineering bulletins. Simplex Valve & Meter Co., 6750 Upland St., Philadelphia 42, Pa.

Save Trucks and Labor In City Rubbish Collection

35. For saving trucks, labor, and time in city rubbish collection get details of the new Dumpster-Kolector described in literature just published by Dempster Brothers, Inc., 996 Higgins, Knoxville 17, Tenn.

Packaged Sewage Treatment—Just Right for Small Places

36. "Packaged" Sewage Treatment Plants specifically developed for small communities — 100 to 3,000 population. Write for full description and actual operating data for this type of plant. Chicago Pump Co., 2348 Wolfram St., Chicago 18, Ill.

Need Low-Cost Air For Sewage Treatment?

39. New booklet on Centrifugal and Rotary Positive Blowers engineered to fit your needs: air for activated sludge; constant vacuum for filters; priming centrifugal pumps; measuring sludge gas; water treatment. Write Roots-Connersville Blower Corp., 712 Poplar Ave., Connersville, Ind.

Valuable Booklet on Porous Diffuser Plates and Tubes

40. A valuable booklet on porous diffuser plates and tubes for sewage treatment plant. Covers permeability, porosity, pore size and pressure loss data, with curves. Also information on installations, with sketches and pictures, specifications, methods of cleaning and studies in permeability, 20 pp. illustrated. Write to Norton Company, Dept. P.W., Worcester 6, Mass.

Solve Corrosion Problems With This Special Alloy

41. "Everdur Metal" is title of an 8-page illustrated booklet describing advantages of this corrosion-resisting alloy for sewage treatment equipment, reservoir, and waterworks service. Dept. P.W., the American Brass Co., 25 Broadway, N. Y. C.

Design Details for Sludge Collectors

42. Booklet No. P.W. 1642 on Link-Belt Circuline Collectors contains sanitary engineering data and design details. Catalog No. 1742 on Straightline Collectors, contains layout drawings, illustration pictures and capacity tables. Address Link-Belt Co., 2045 West Hunting Park Ave., Philadelphia 40, Pa.

STREETS AND HIGHWAYS

Protect Your Grade Crossings With Model 10 Signals

45. Bulletin G17-PW6 describes and illustrates the automatically operated Model 10 railroad crossing signal. Folder describing this signal which guards against "second train" accidents and permits fast flow of rail and highway traffic is available on request from Western Railroad Supply Co., 2406-2436 South Ashland Ave., Chicago 8, Ill.

Data on All Types of Bins and Batching Plants

47. Good illustrations and useful data on all types of Heltzel Highway Bins, for truck mixer charging, bulk cement plants, enclosed bucket elevators, belt conveyors, etc. Heltzel Steel Form & Iron Co., Dept. P.W., Warren, O.

Speed Your Work With These Powerful Motor Graders

48. Two powerful Galion motor graders designed to answer every requirement for more speed in road, airport, dam and housing construction work are fully described in a folder illustrated with many action pictures. Issued by Galion Iron Works & Mfg. Co., Galion, Ohio.

Practical Portable Power Units for Every Need

49. M-M power units with heavy duty engine, positive lubrication, easy servicing, handy controls may be just what you have been looking for. Simple, durable, practical. Get latest bulletin from Dept. P.W., Minneapolis Moline Power Implement Co., Minneapolis 1, Minn.

Here's Your Diesel Tractor!

50. Big 48 page catalog describes and lists many uses for International Diesel Tractors. Write International Harvester Co., Dept. P.W., 180 North Michigan Ave., Chicago 1, Ill.

Latest Maintenance Equipment For Blacktop Roads

52. "Blacktop Road Maintenance and Construction Equipment" — Asphalt and tar kettles, flue type kettles, spray attachments, tool heaters, surface heaters, road brooms and rollers. This is modern and up-to-date equipment for blacktop airport and road construction and maintenance. Write for Catalog R. Littleford Bros., Inc., 452 East Pearl St., Cincinnati 2, Ohio.

WATER WORKS

Eliminate Taste and Odor From Your Water

53. Technical pub. No. P.W. 213 issued by Wallace & Tiernan Co., Inc., Newark 1, N. J., describes in detail taste and odor control of water with BREAK-POINT Chlorination. Send free to any operator requesting it.

Simple Method of Underground Pipe Installation

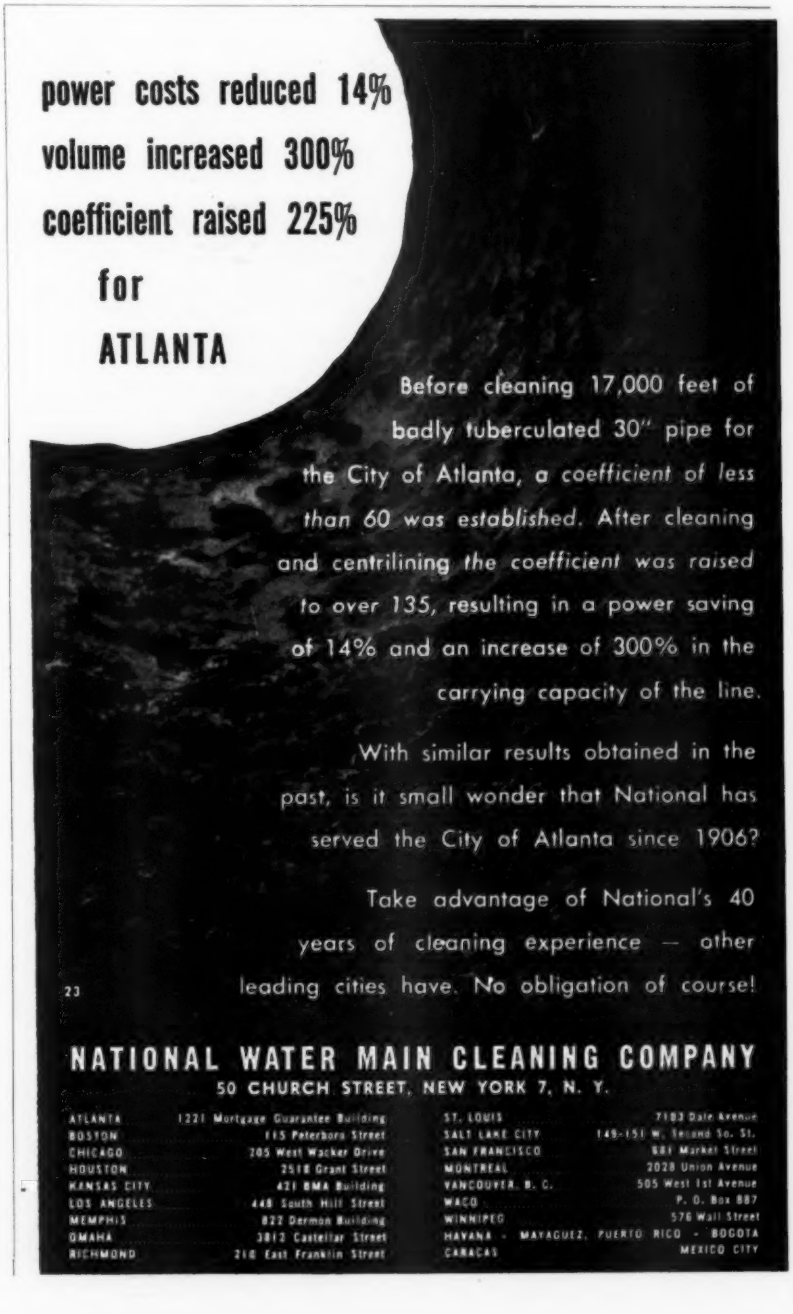
54. For bulletin on simple method of underground pipe installation for distances up to 150 or 200 feet by boring with the Hydrauger write to Hydrauger Corp., Ltd., 681 Market Street, San Francisco 5, Calif.

Here's Data on All Swimming Pool Needs

55. Well illustrated bulletin describes Filters, Water Softeners, Hydrogen Ion Plants and Complete Equipment for Swimming pools, etc. Copy sent on request by Dept. PW., Chemical Equipment Co., 223 Center Street, Los Angeles 54, Calif.

Have You a Water Conditioning Problem?

56. Installation-tested equipment for complete municipal and industrial systems or individual units. Illustrated and described in latest booklets from Dept. P.W., American Wells Works, Aurora, Ill.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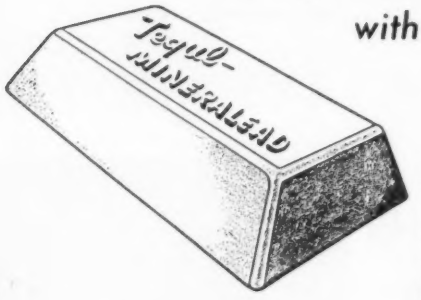

Tegul-MINERALEAD sidesteps trouble met with in some jointing compounds. Its correct composition is never upset as the result of rough travel between plant and job. No amount of jolting can "shake down" an ingot.

Also the ingot is more convenient to ship, store and handle, is impervious to moisture so may be stored unprotected in the open without fear of rain or flood. It melts and pours easily. Less initial leakage and, due to plasticising with synthetic rubber, has super resistance to mechanical and thermal shock. Joints made with *Tegul*-MINERALEAD have ample flexibility to meet vibration and to permit line to adjust to any normal settling of terrain.

Tegul-MINERALEAD is easy—and clean to work with. Economical too—needs no skilled labor, caulking or deep bell holes.

THE HYDE-RO RING is a simple, easily applied rubber device which makes a quick seal, makes repeated hypochlorite flushings unnecessary, prevents recontamination of the line — and speeds repairs by giving dry joints.

The Hyde-Ro Ring works with plain or bead end pipe and with *Tegul*-MINERALEAD, lead and Portland Cement. Made for diameters from 4 to 12" and packed fifty rings of a size to carton.

Stocks of *Tegul*-MINERALEAD and Hyde-Ro Rings are maintained at strategic points. Contact our nearest branch—and write Mertztown office for Bulletin W7-A.

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IN CANADA: Atlas Products are manufactured by H. L. BLACHFORD, Limited, 977 Aqueduct Street, Montreal 3, P. Q., 86 Bloor St. W., Toronto, Ont.

We manufacture also G—K, the Original Bituminous Sewer Jointing Compound

USE COUPON ON PAGE 85 *TODAY* TO ORDER THE LITERATURE YOU NEED.

Quick Way to Locate Leaks and Pipe

57. Leak Locators. Again available to waterworks superintendents, the Globe line of leak locators, dipping needles and pipe finders. Several leaflets describing the original Geophone leak locator, Little Wonder pipe phone, and the Magnetite Dipping Needle. Globe Phone Mfg. Corp., Dept. P., Reading, Mass.

To Measure, Mix, Feed Chlorine or Other Gases

58. Everson SterElators. Bulletins 1063, 1066, 708 and others describe this device for measuring, mixing and feeding chlorine or other gases in solution. Capacities range from ¼ lb. to 2,000 lb. of gas per 24 hours. Address: Everson Manufacturing Co., 214 W. Huron St., Chicago 10, Ill.

Hydraulic Pipeline Scraper For Water and Sewage Mains

59. For a copy of this compact folder on a hydraulic pipeline scraper which cleans all kinds of mains from 4 inches to 14 inches write to Dept. PW, Carver-Stimpson Pipe Cleaning Co., Walters, Okla.

Chem-O-Feeders for Automatic Chemical Feeding

60. For chlorinating water supplies, sewage plants, swimming pools and feeding practically any chemical used in sanitation, treatment of water and sewage. Flow of water controls dosage of chemical; reagent feed is immediately adjustable. Starts and stops automatically. Literature from % Proportioneers, Inc. %, 96 Codding St., Providence 1, R. I.

What You Should Know About Meter Setting and Testing Equipment

61. The most complete catalog we have seen on setting and testing equipment for water meters—exquisitely printed and illustrated 40-page booklet P.W. You should have a copy. Ask: Ford Meter Box Co., Wabash, Ind.

All Kinds of Valves And Hydrants

63. Hydrants and Valves. Catalog P. W. covers fire protection appliances, including hydrants, gates and check valves. Catalog also describes sluice gates, shear gates, and flap, mud, gate, check and foot valves. Address: Mueller Company, Chattanooga, Tenn.

Helpful Data on Hydrants

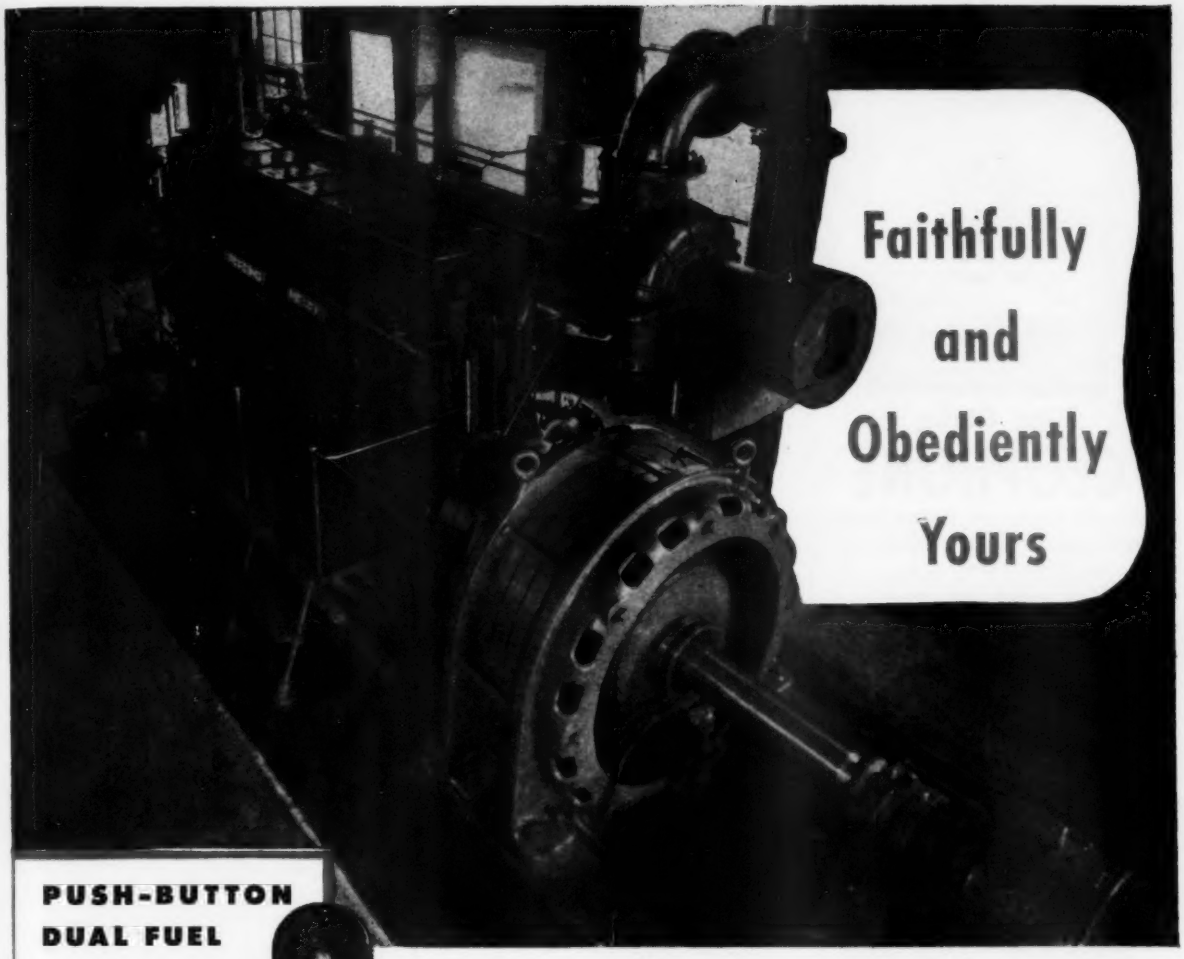
64. Specifications for standard AWWA fire hydrants with helpful instructions for ordering, installing, repairing, lengthening and using. Issued by M. & H. Valve & Fittings Co., Dept. P.W., Anniston, Ala.

How to Use Alum For Coagulation

70. Alum for coagulation in both sewage and water plants is the subject of literature now available from Dept. PW, General Chemical Division, 40 Rector St., New York 6, N. Y.

88 Page Book Helps Solve Water Problems

71. pH and Chlorine Control. A discussion of pH control and description of comparators, chlorimeters and similar devices. An 88 page booklet. W. A. Taylor & Co., 7304 York Road, Baltimore 4, Md.



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